FINAL SUBMITTAL

ENERGY ENGINEERING ANALYSIS PROGRAM

LIMITED ENERGY STUDY

WATERVLIET ARSENAL

WATERVLIET, NEW YORK

VOLUME I

NARRATIVE REPORT

CONTRACT NO. DACA65-91-C-0072

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS
NORFOLK, VIRGINIA

PREPARED BY:

REYNOLDS, SMITH AND HILLS, INC.
ENERGY AND ENVIRONMENTAL SERVICES DEPARTMENT
P.O. BOX 4850
JACKSONVILLE, FLORIDA 32201

PROJECT NO. 2900379002

AUGUST 1992

8/92

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

REPLY TO
ATTENTION OF: TR-I Library

17 Sep 1997

Based on SOW, these Energy Studies are unclassified/unlimited. Distribution A. Approved for public release.

Marie Wakefield,
Librarian Engineering

TABLE OF CONTENTS

		Page
VOLUME I--NARRATIVE REPORT		
EXECUTIVE SUMMARY		i
1.0	INTRODUCTION	1-1
1.1	Authorization	1-1
1.2	Objectives	1-1
1.3	Phases of Work	1-2
1.4	Submission Requirements	1-2
1.5	Work Accomplished	1-2
1.6	Report Organization	1-3
2.0	EXISTING CONDITIONS	2-1
2.1	Installation Description	2-1
2.2	Process Descriptions	2-1
2.3	Historical Energy Use and Costs	2-16
2.4	Review of Energy Documents	2-16
3.0	METHODOLOGY	3-1
3.1	Site Survey	3-1
3.2	Energy Analysis	3-1
4.0	ENERGY ANALYSIS	4-1
4.1	Energy Conservation Opportunity (ECO) Evaluations	4-1
4.2	Multiple ECO Projects Evaluation	4-77
4.3	Operation and Maintenance Savings	4-80
5.0	ENERGY PLAN	5-1
5.1	Project Packaging	5-1
5.2	Energy and Cost Savings	5-1
5.3	Project Schedule	5-6
5.4	Environmental Impact	5-6
VOLUME II--APPENDICES		
A	Prenegotiation Meeting Minutes and Work Scope	
B	Backup Data, Calculations and Cost Estimates	
VOLUME III--SITE SURVEY NOTES		
VOLUME IV--PROGRAMMING DOCUMENTS		

FINAL SUBMITTAL

ENERGY ENGINEERING ANALYSIS PROGRAM

LIMITED ENERGY STUDY

WATERVLIET ARSENAL

WATERVLIET, NEW YORK

EXECUTIVE SUMMARY

CONTRACT NO. DACA65-91-C-0072

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS
NORFOLK, VIRGINIA

PREPARED BY:

REYNOLDS, SMITH AND HILLS, INC.
ENERGY AND ENVIRONMENTAL SERVICES DEPARTMENT
P.O. BOX 4850
JACKSONVILLE, FLORIDA 32201

PROJECT NO. 2900379002

AUGUST 1992

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Section	Title	Page
1.0	INTRODUCTION	ES-1
2.0	INSTALLATION DESCRIPTION	ES-2
3.0	ENERGY CONSUMPTION	ES-5
4.0	ENERGY CONSERVATION ANALYSIS	ES-13
5.0	ENERGY PLAN	ES-21

1.0 INTRODUCTION

1.1 Authorization

The Energy Engineering Analysis Program (EEAP), Limited Energy Study (LES), Watervliet Arsenal (WVA), Watervliet, New York was authorized by the Department of the Army, Norfolk District Corps of Engineers, under Contract Number DACA65-91-C-0072.

1.2 Objectives

The objectives of this contract, as explained in the Detailed Scope of Work (Appendix A in Volume II) of the contract are as follows:

A. Review, use and incorporate applicable data and results of the previously completed Energy Engineering Analysis Program study.

B. Perform a limited site audit and analysis of the industrial facility.

C. Re-evaluate specific projects or ECOs from the previous study to determine its economic feasibility based on revised criteria, current site conditions and technical applicability. However, no previously identified process energy-related projects or ECOs were selected by Watervliet Arsenal.

D. Evaluate specific ECOs to determine their energy savings potential and economic feasibility as indicated in the Appendix of the Scope of Work.

E. Prepare programming and implementation documentation for all justifiable ECOs.

F. Prepare a comprehensive report which will document the work accomplished, the results and the recommendations.

1.3 Report Organization

The report consists of six volumes. Volume I, the Narrative Report, contains the results of all of the site surveys, analysis and project development. All backup data and calculations are found in Volume II. The site survey notes are in Volumes III (Production Facilities) and IIIa (Ancillary Facilities), and project documentation forms necessary for receiving funding are in Volume IV. Also included is an Executive Summary volume.

2.0 INSTALLATION DESCRIPTION

Watervliet Arsenal (WVA) is a government-owned, government-operated (GOGO) production facility under AMC direction. The Arsenal's mission is to manufacture cannons, special tools, test equipment, and training devices needed to support large caliber weapons. The facility is equipped to produce cannons with bore diameters from 20mm to 16 inches. WVA is also the home of Benet Weapons Laboratory, active in weapons-related research, development and processes. The installation site plan is contained in Figure 2-1.

There are 80 buildings at the Arsenal, representing over two million square feet of space. Most buildings are dedicated to manufacturing and administration.

2.1 Production Facilities

The basic process flow diagram between the buildings surveyed are shown in Figure 2-2. The raw materials for making the major gun tube components, minor gun tube components, other components, and gun tubes are brought to Buildings 20, 25, 125 and 135, respectively. Building 35 receives the gun tube and other components in a rough form, and various other machining operations as well as plating are performed here. The final step in the process is performed in Building 110 where the assemblies are painted, preserved and packaged for shipment. These buildings represent about 1.2 million square feet or 60 percent of the installation total.

2.2 Ancillary Facilities

Ancillary facilities are defined here as non-production buildings. This includes administration, laboratories and support services as well as other non-energy-intensive buildings. All of these buildings are masonry typically utilizing a dark red brick. Since WVA began in 1814, there are many buildings of historical interest. All buildings surveyed, except Building 145, are heated via steam from the main boiler plant, Building 136. Ancillary facilities have a total floor space of about 900,000 square feet.

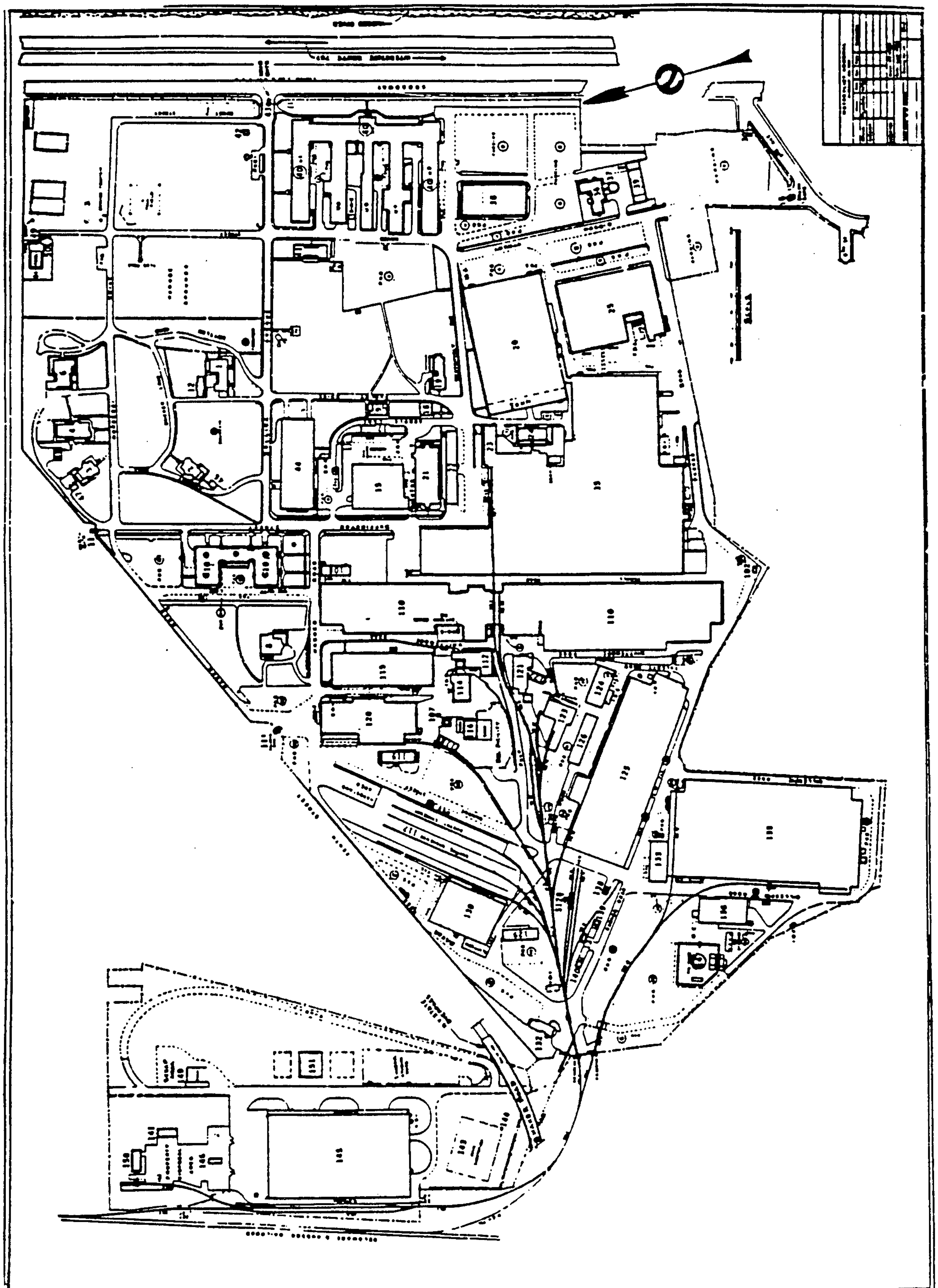


Figure 2-1
Watervliet Arsenal Site Map

Watervliet Arsenal

Basic Process Flow Diagram

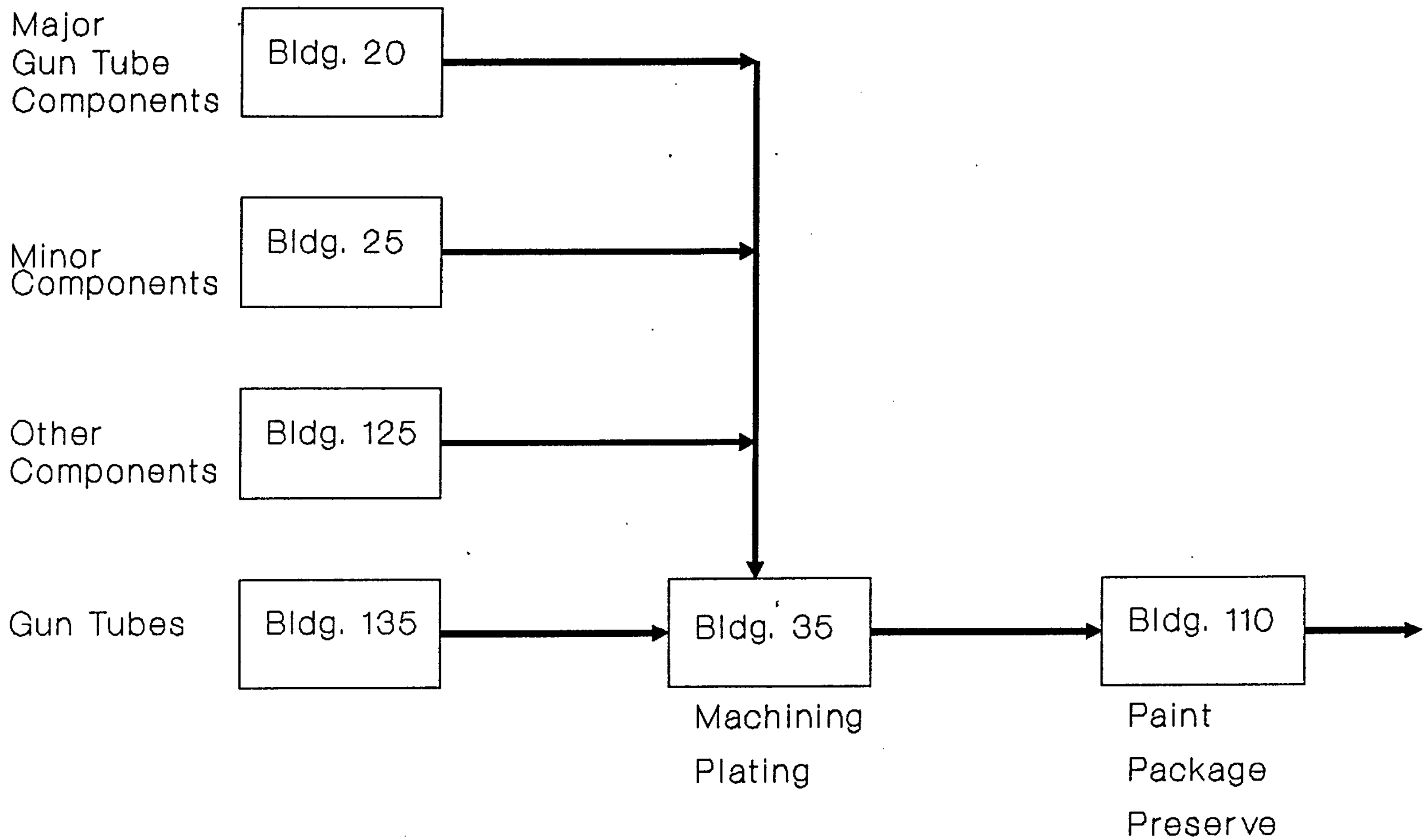


Figure 2-2

3.0 ENERGY CONSUMPTION

3.1 Energy Use

Total facility and production energy consumption at WVA increased by approximately 3.6 percent from FY 85 through FY 91 (Figure 3-1). The cause for the increase was because of increases in the use of electricity and natural gas which increased 8.5 percent and 45 percent, respectively. Residual fuel oil and distillate consumption decreased 5.0 percent and 70 percent.

Monthly consumption of heating fuels and electricity for FY 91 is shown in Figure 3-2. The strong dependence of heating fuels on weather is readily apparent, although some steam is generated during the summer months for uses other than space heating (metal plating in Building 35). Electricity use is fairly constant throughout the year, showing that almost all electricity consumption is strictly production related.

Percentages of fuel use for FY 91 are shown in Figure 3-3 . The heating fuels accounted for approximately 68 percent of energy use in that year.

3.2 Costs

Total annual energy costs at WVA were unusually high in FY 91, about 33 percent over the FY 85 values (Figure 3-4). The changes in costs reflect changes in unit pricing over the same time period (Figure 3-5). The main reason for the increase was the large increase in fuel oil costs due to the impact of Desert Shield in late summer 1991. Iraq occupation of Kuwait caused oil prices to skyrocket. Unfortunately, this was in the same time period that the Army negotiated its annual fuel oil contracts four all CONUS installations.

Monthly energy costs at WVA are shown in Figure 3-6. As in the case of consumption, boiler fuel costs vary widely, depending on weather. Electricity costs are a significant portion of the monthly costs, and can range from 55 percent of the monthly total to 90+ percent.

Electricity costs dominate the total annual energy bill because of the higher unit price. In FY 91, even with the unusually high fuel oil prices, electricity costs represented over 60 percent of the total expense of $6,024,000 (Figure 3-7).

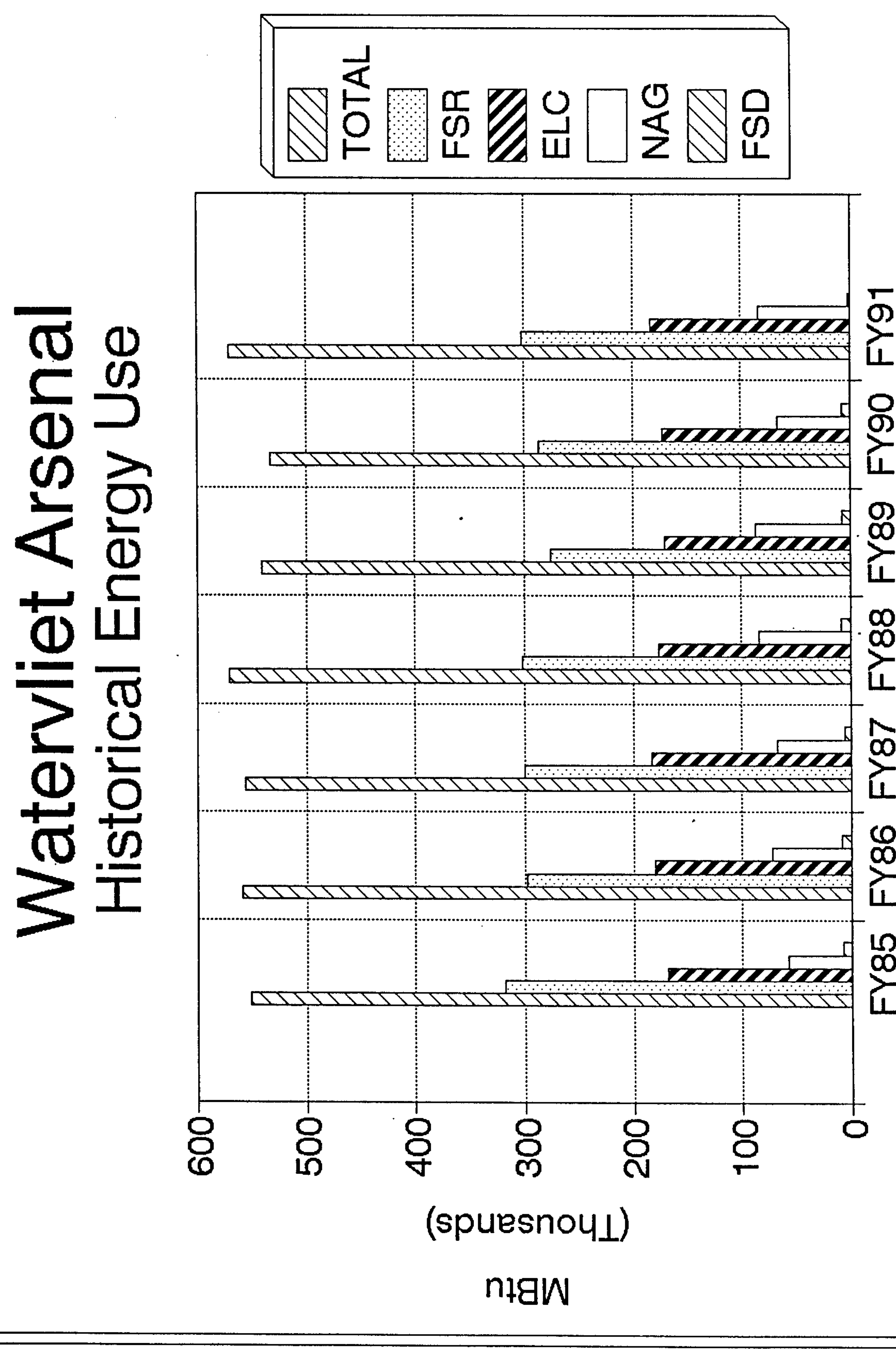
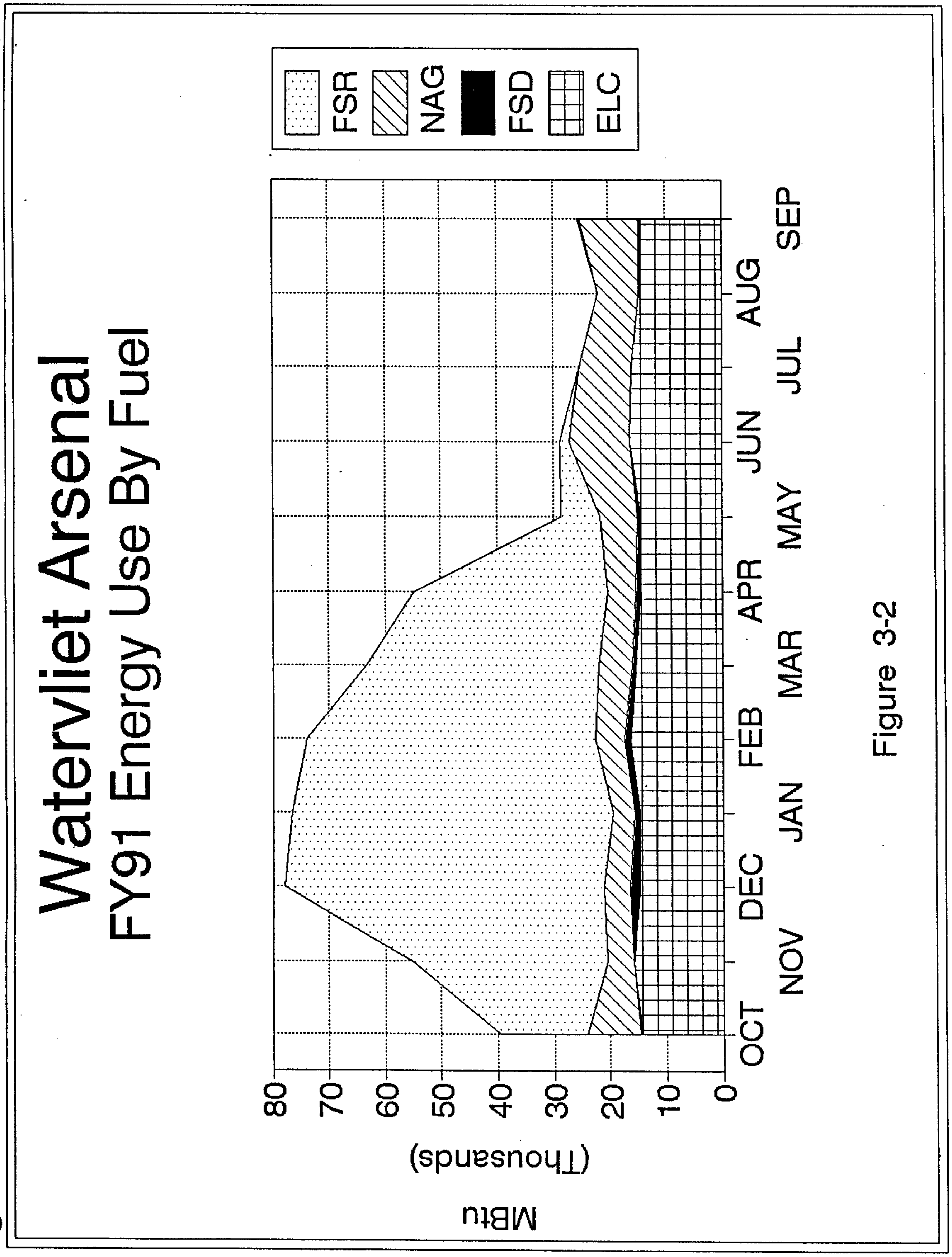
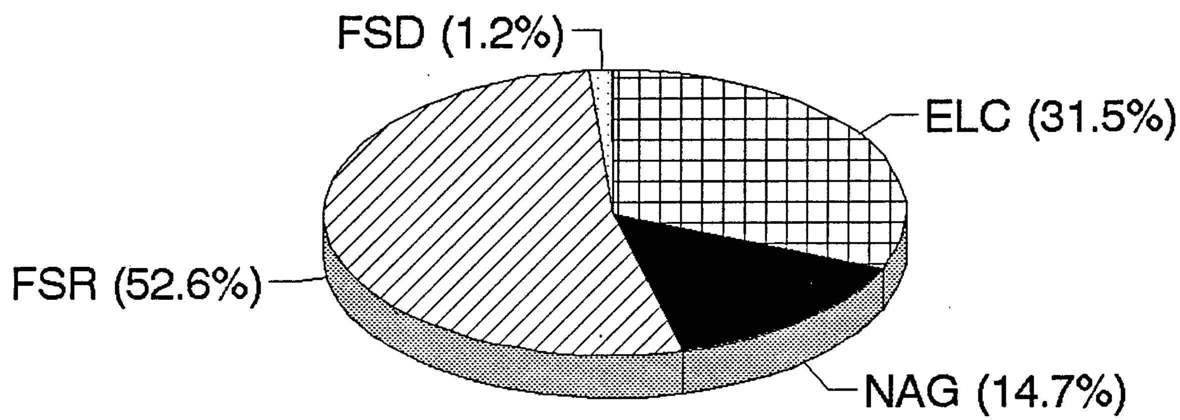

Watervliet Arsenal
Historical Energy Use
TOTAL
FSR
ELC
NAG
FSD
MBtu
(Thousands)
600
500
400
300
200
100
0
FY85
FY86
FY87
FY88
FY89
FY90
FY91

Figure 3-1


Watervliet Arsenal
FY91 Energy Use By Fuel
MBtu
(Thousands)
80
70
60
50
40
30
20
10
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FSR
NAG
FSD
ELC
Figure 3-2

Watervliet Arsenal
FY91 Facility Energy Use



Total Use = 571,000 MBtu

Figure 3-3

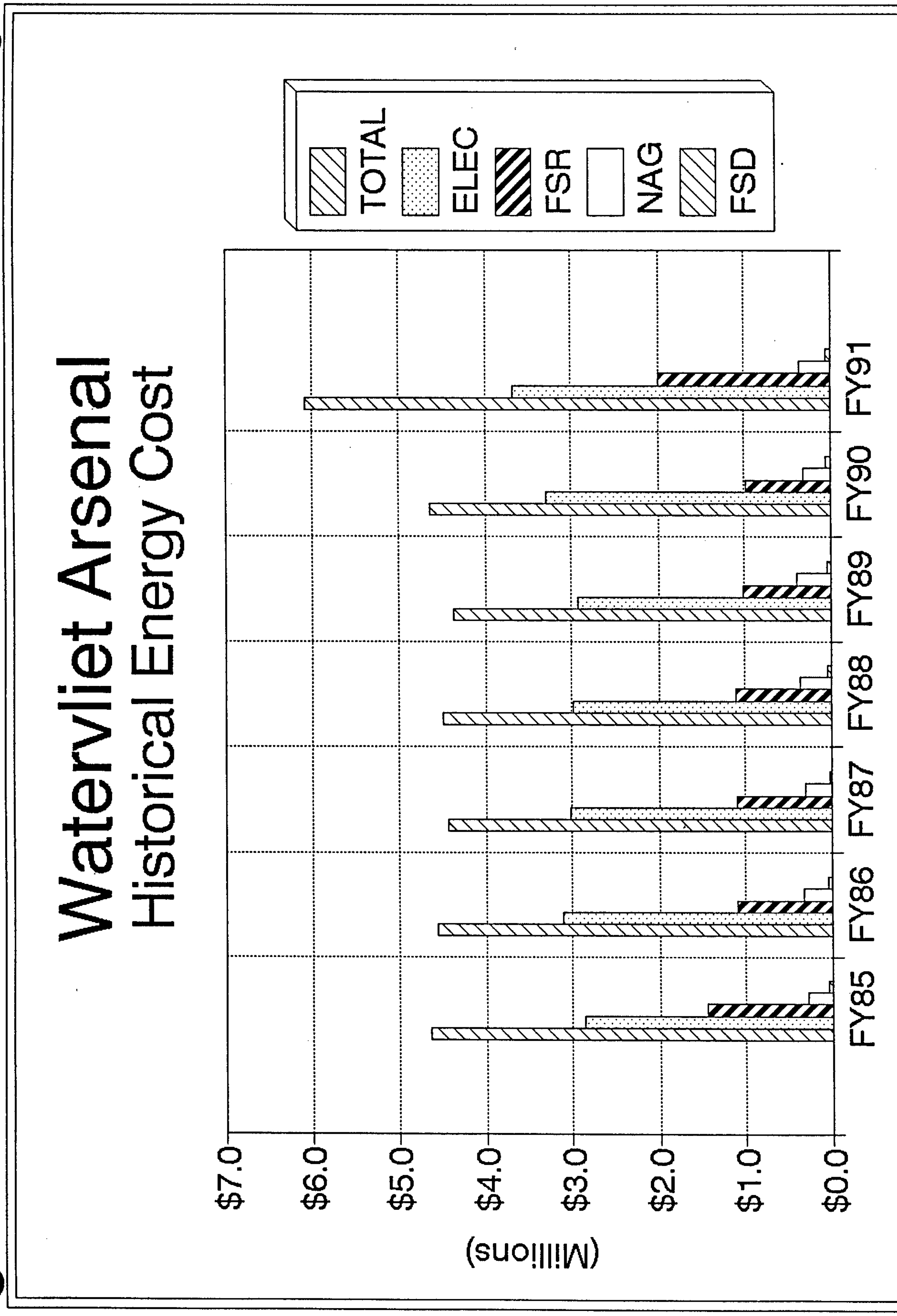

Watervliet Arsenal
Historical Energy Cost
TOTAL
ELEC
FSR
NAG
FSD
(Millions)
$7.0
$6.0
$5.0
$4.0
$3.0
$2.0
$1.0
$0.0
FY85
FY86
FY87
FY88
FY89
FY90
FY91

Figure 3-4

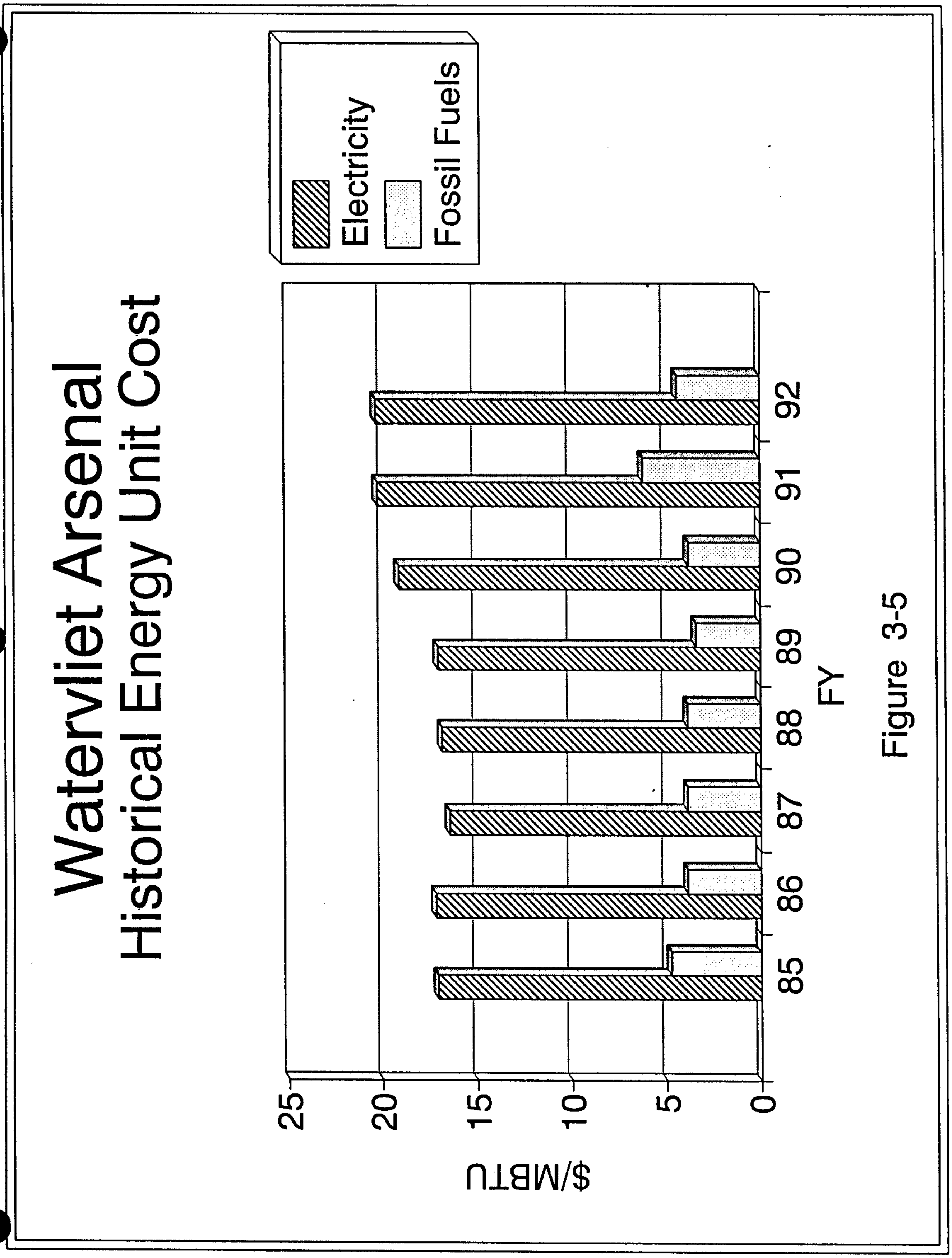

Watervliet Arsenal
Historical Energy Unit Cost
$/MBTU
0
5
10
15
20
25
85
86
87
88
89
90
91
92
FY
Electricity
Fossil Fuels

Figure 3-5

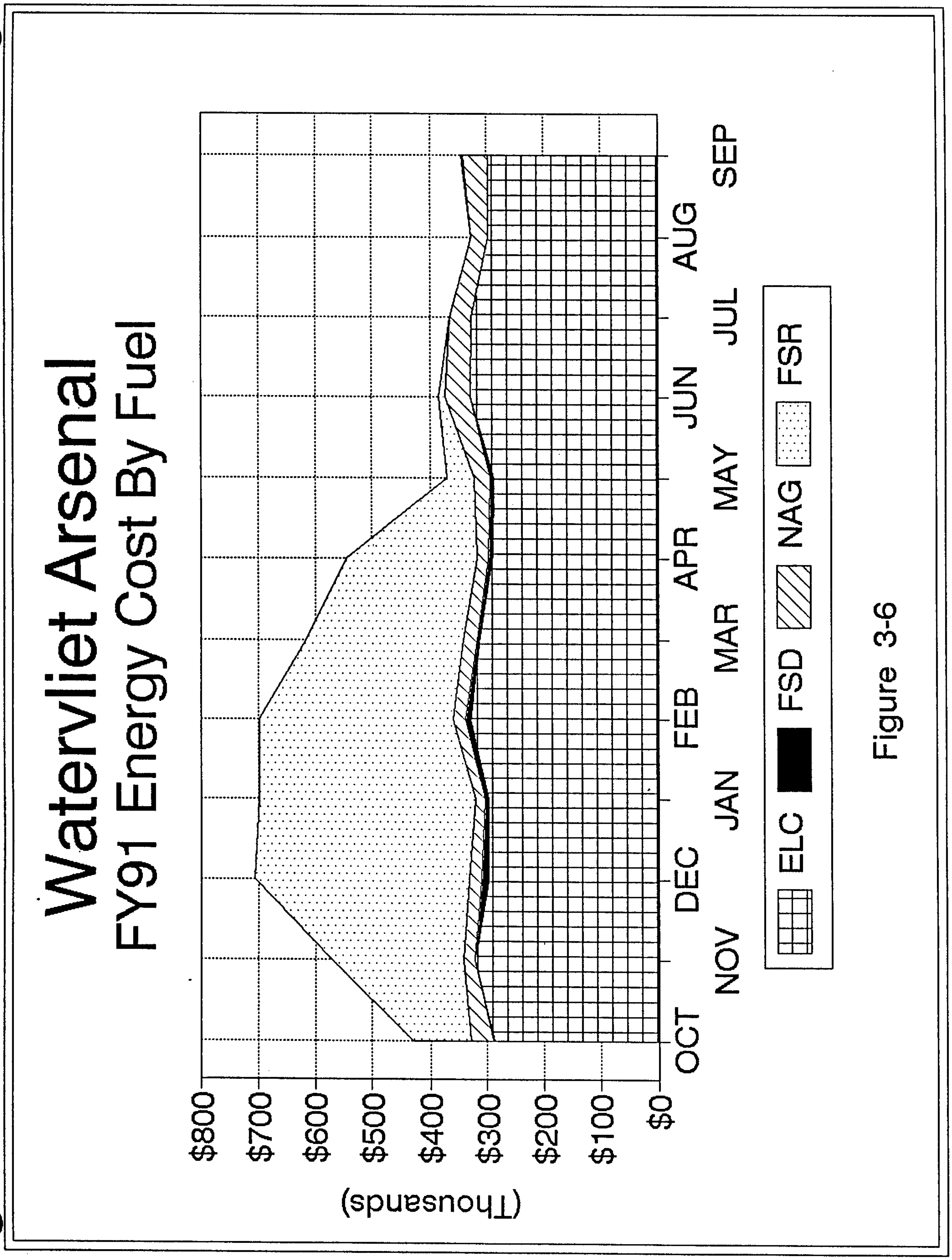
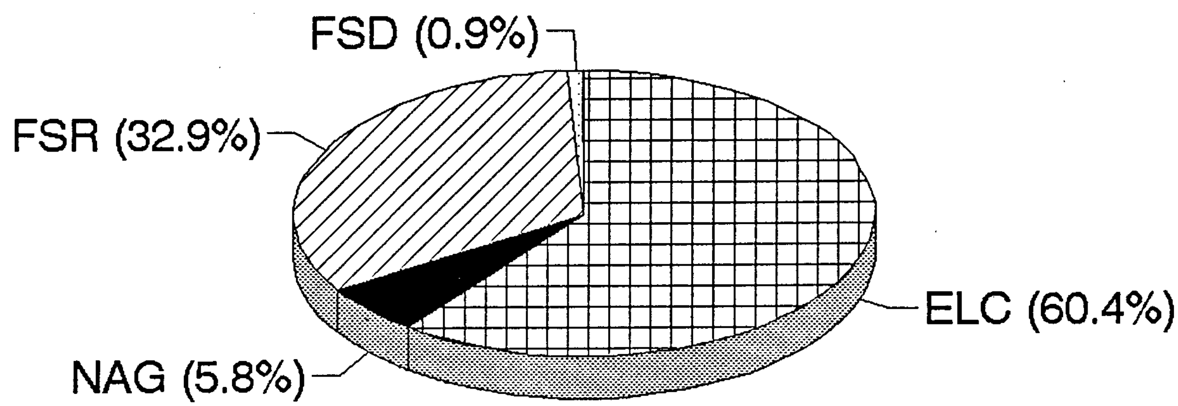

Watervliet Arsenal
FY91 Energy Cost By Fuel
(Thousands)
$800
$700
$600
$500
$400
$300
$200
$100
$0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
ELC
FSD
NAG
FSR

Figure 3-6

Watervliet Arsenal
FY91 Facility Energy Cost



Total Cost = $ 6,024,000

Figure 3-7

4.0 ENERGY ANALYSIS

4.1 Energy Conservation Opportunity (ECO) Evaluations

Each of the ECOs listed in the Scope of Work plus others were reviewed for their applicability and potential for significant energy savings and cost effectiveness for buildings representative of high energy consumption process areas at WVA. The results of this assessment are contained in tables in Appendix B.

For each of the ECOs that were chosen to be evaluated, energy savings were calculated, cost estimates made and Life Cycle Cost Analyses performed. A summary of the results are contained in Tables 4-1 and 4-2. The evaluated ECOs are described and listed in Table 4-1. An alphabetical listing of evaluated ECOs along with a summary of the energy and cost savings analysis is shown in Table 4-2. Table 4-3 contains a listing prioritized by SIR. Table 4-4 contains a list prioritized by simple payback. Backup data and calculations are contained in Appendix B.

Table 4-1. ECOs Evaluated--Titles

ECO #	Description
1	Power factor improvement
2	Natural gas fuel switch at the main boiler plant
3	Cogeneration
4	Dip tank covers with exhaust fan motor variable-speed drives
5	Electrical demand peak reduction
6	Plating area condensate return system
7	Condenser fan variable speed drives
8	High-efficiency fluorescent lighting and ballasts
9	Not used
10	High-efficiency electric motors
11	Boiler O_2 trim controls
12	Natural gas boilers
13	Reduce HVAC system air flow
14	High-efficiency chiller
15	EMCS
16	Return air system
17	Double pane windows
18	Storm windows
19	Occupancy sensors

Table 4-2. ECO Evaluations - Results

No.	ECO #	Project Name	Construction Cost Plus SIOH	Savings (Increase), MBtu/Year Elec	Dist	Resid	N Gas	Net Annual Cost Savings	SIR	Simple Payback (yrs)
1	1	Power Factor Improvement	$138,786	0	0	0	0	$31,000	3.1	4.7
2	2	Natural Gas Fuel Switch	$364,051	0	0	278,000	(278,000)	$66,700	4.4	5.8
3	3	Cogeneration	$1,303,232	0	0	28,400	(77,700)	$140,500	1.0	9.8
4	4	Dip Tank Covers & VSDs	$202,576	2,707	0	21,650	0	$141,900	11.6	1.5
5	5	Elec. Demand Peak Reduction	$0	0	0	0	0	$151,000	∞	0
6	6	Condensate Return	$16,712	0	0	2,255	3,205	$23,300	24.1	0.8
7	7	Condenser Fan VSDs	--	--	--	--	--	--	--	--
8	8A	34 W FL-Prod	$2,065	51	0	0	0	$970	6.8	2.2
9	8B	34 W FL&EB-Prod	$12,299	102	0	0	0	$2,000	2.6	6.1
10	8C	T8 FL&EB-Prod	$10,490	117	0	0	0	$2,400	3.3	4.7
11	8D	34W FL-NonProd	$52,591	589	0	0	0	$11,300	3.1	4.9
12	8E	34W FL&EB-NonProd	$316,753	1,104	0	0	0	$24,900	1.3	13.4
13	8F	T8 FL&EB-NonProd	$361,167	1,399	0	0	0	$30,600	1.3	12.5
14	8G	60W FL-Prod	$64,691	768	0	0	0	$13,200	3.0	5.2
15	8H	60W FL-Prod	$367,198	4,478	0	0	0	$91,200	3.6	4.3
16	8I	60W FL-NonProd	$108,685	58	0	0	0	$15,500	1.4	11.2
17	8J	60W FL&EB-NonProd	$60,651	339	0	0	0	$7,100	1.7	9.0
18	9	Not Used	--	--	0	0	0	--	--	--
19	10	High-Efficiency Motors	$111,227	1,602	0	0	0	$32,600	4.2	3.6
20	11	Boiler O2 Trim Controls	--	--	--		--	--	--	--
21	12	Natural Gas Boilers	$47,268	2,497	0	0	(3,122)	$37,800	10.7	1.3
22	13	Air Flow Reduction	$969	31	0	25	0	$740	11.4	1.4
23	14	High-Efficiency Chiller	$141,184	363	0	0	0	$7,400	0.8	20.2
24	15	EMCS	$522,900	0	0	9,851	0	$49,600	1.1	11.2
25	16	Return Air System	$66,495	0	0	3,985	0	$17,500	4.6	4.0
26	17	Double-Pane Wind. (1)	$495	0.02	0	2.55	0	$12	0.4	45.9
27	18	Storm Windows (1)	$107	0.02	0	2.55	0	$11	1.8	10.5
28	19	Occupancy Sensors	$11,976	211	0	0	0	$4,600	5.5	2.8

Note : VSD = Variable speed drive
FL = Fluorescents
EB = Electronic ballasts
Prod = Production areas
NonProd = Non-production areas
T8 = T8 fluorescents
(1) Per unit basis

Table 4-3. ECO Evaluations - Results Prioritized by SIR

No.	ECO #	Project Name	Construction Cost Plus SIOH	Savings (Increase), MBtu/Year Elec	Dist	Resid	N Gas	Net Annual Cost Savings	SIR	Simple Payback (yrs)
1	5	Elec. Demand Peak Reduction	$0	0	0	0	0	$151,000	∞	0
2	6	Condensate Return	$16,712	0	0	2,255	3,205	$23,300	24.1	0.8
3	4	Dip Tank Covers & VSDs	$202,576	2,707	0	21,650	0	$141,900	11.6	1.5
4	13	Air Flow Reduction	$969	31	0	25	0	$740	11.4	1.4
5	12	Natural Gas Boilers	$47,268	2,497	0	0	(3,122)	$37,800	10.7	1.3
6	8A	34 W FL-Prod	$2,065	51	0	0	0	$970	6.8	2.2
7	19	Occupancy Sensors	$11,976	211	0	0	0	$4,600	5.5	2.8
8	16	Return Air System	$66,495	0	0	3,985	0	$17,500	4.6	4.0
9	2	Natural Gas Fuel Switch	$364,051	0	0	278,000	(278,000)	$66,700	4.4	5.8
10	10	High-Efficiency Motors	$111,227	1,602	0	0	0	$32,600	4.2	3.6
11	8H	60W FL-Prod	$367,198	4,478	0	0	0	$91,200	3.6	4.3
12	8C	T8 FL&EB-Prod	$10,490	117	0	0	0	$2,400	3.3	4.7
13	8D	34W FL-NonProd	$52,591	589	0	0	0	$11,300	3.1	4.9
14	1	Power Factor Improvement	$138,786	0	0	0	0	$31,000	3.1	4.7
15	8G	60W FL-Prod	$64,691	768	0	0	0	$13,200	3.0	5.2
16	8B	34 W FL&EB-Prod	$12,299	102	0	0	0	$2,000	2.6	6.1
17	18	Storm Windows (1)	$107	0.02	0	2.55	0	$11	1.8	10.5
18	8J	60W FL&EB-NonProd	$60,651	339	0	0	0	$7,100	1.7	9.0
19	8I	60W FL-NonProd	$108,685	58	0	0	0	$15,500	1.4	11.2
20	8E	34W FL&EB-NonProd	$316,753	1,104	0	0	0	$24,900	1.3	13.4
21	8F	T8 FL&EB-NonProd	$361,167	1,399	0	0	0	$30,600	1.3	12.5
22	15	EMCS	$522,900	0	0	9,851	0	$49,600	1.1	11.2
23	3	Cogeneration	$1,303,232	0	0	28,400	(77,700)	$140,500	1.0	9.8
24	14	High-Efficiency Chiller	$141,184	363	0	0	0	$7,400	0.8	20.2
25	17	Double-Pane Wind. (1)	$495	0.02	0	2.55	0	$12	0.4	45.9
26	11	Boiler O2 Trim Controls	--	--	--	--	--	--	--	--
27	9	Not Used	--	--	0	0	0	--	--	--
28	7	Condenser Fan VSDs	--	--	--	--	--	--	--	--

Note : VSD = Variable speed drive
FL = Fluorescents
EB = Electronic ballasts
Prod = Production areas
NonProd = Non-production areas
T8 = T8 fluorescents
(1) Per unit basis

Table 4-4. ECO Evaluations - Results Prioritized by Simple Payback

No.	ECO #	Project Name	Construction Cost Plus SIOH	Savings (Increase), MBtu/Year Elec	Dist	Resid	N Gas	Net Annual Cost Savings	SIR	Simple Payback (yrs)
1	5	Elec. Demand Peak Reduction	$0	0	0	0	0	$151,000	∞	0.0
2	6	Condensate Return	$16,712	0	0	2,255	3,205	$23,300	24.1	0.8
3	12	Natural Gas Boilers	$47,268	2,497	0	0	(3,122)	$37,800	10.7	1.3
4	13	Air Flow Reduction	$969	31	0	25	0	$740	11.4	1.4
5	4	Dip Tank Covers & VSDs	$202,576	2,707	0	21,650	0	$141,900	11.6	1.5
6	8A	34 W FL-Prod	$2,065	51	0	0	0	$970	6.8	2.2
7	19	Occupancy Sensors	$11,976	211	0	0	0	$4,600	5.5	2.8
8	10	High-Efficiency Motors	$111,227	1,602	0	0	0	$32,600	4.2	3.6
9	16	Return Air System	$66,495	0	0	3,985	0	$17,500	4.6	4.0
10	8H	60W FL-Prod	$367,198	4,478	0	0	0	$91,200	3.6	4.3
11	1	Power Factor Improvement	$138,786	0	0	0	0	$31,000	3.1	4.7
12	8C	T8 FL&EB-Prod	$10,490	117	0	0	0	$2,400	3.3	4.7
13	8D	34W FL-NonProd	$52,591	589	0	0	0	$11,300	3.1	4.9
14	8G	60W FL-Prod	$64,691	768	0	0	0	$13,200	3.0	5.2
15	2	Natural Gas Fuel Switch	$364,051	0	0	278,000	(278,000)	$66,700	4.4	5.8
16	8B	34 W FL&EB-Prod	$12,299	102	0	0	0	$2,000	2.6	6.1
17	8J	60W FL&EB-NonProd	$60,651	339	0	0	0	$7,100	1.7	9.0
18	3	Cogeneration	$1,303,232	0	0	28,400	(77,700)	$140,500	1.0	9.8
19	18	Storm Windows (1)	$107	0.02	0	2.55	0	$11	1.8	10.5
20	8I	60W FL-NonProd	$108,685	58	0	0	0	$15,500	1.4	11.2
21	15	EMCS	$522,900	0	0	9,851	0	$49,600	1.1	11.2
22	8F	T8 FL&EB-NonProd	$361,167	1,399	0	0	0	$30,600	1.3	12.5
23	8E	34W FL&EB-NonProd	$316,753	1,104	0	0	0	$24,900	1.3	13.4
24	14	High-Efficiency Chiller	$141,184	363	0	0	0	$7,400	0.8	20.2
25	17	Double-Pane Wind. (1)	$495	0.02	0	2.55	0	$12	0.4	45.9
26	11	Boiler O2 Trim Controls	--	--	--	--	--	--	--	--
27	9	Not Used	--	--	0	0	0	--	--	--
28	7	Condenser Fan VSDs	--	--	--	--	--	--	--	--

Note : VSD = Variable speed drive
FL = Fluorescents
EB = Electronic ballasts
Prod = Production areas
NonProd = Non-production areas
T8 = T8 fluorescents
(1) Per unit basis

4.2 Multiple ECO Project Evaluations

ECIP Number 1. ECOs 8A through 8J represent a variety of measures for saving energy using high-efficiency fluorescent lamps and fixtures. There are three basic combinations evaluated for replacement:

- Four-foot fluorescents in production areas
- Four-foot fluorescents in non-production areas
- Eight-foot fluorescents in production areas

ECOs 8C, 8D and 8H were selected based on the life cycle cost analysis and combined into a single Energy Conservation Investment Program (ECIP) project.

4.3 Operations and Maintenance Energy Savings

4.3.1 Energy Savings Ideas. As a result of the site visit to WVA, several operations and maintenance (O&M) energy savings ideas were identified. Energy and economic analyses were performed for these recommendations. The results of these analyses are presented below. Calculations for energy savings can be found in Volume II, Appendix B, under O&M Recommendations.

Upon Failure, Replace Standard Fluorescent Lamps with Energy-Efficient Types

Current practice is to replace failed fluorescent lamps with standard 40-watt lamps. Replacing failed lamps with 34-watt lamps saves about $0.95 per year for each lamp in office areas and $3.40 in production buildings. The incremental cost is the difference between the cost of the two lamps, which is $0.81 per lamp. This yields a payback of about 0.9 years for administrative areas and 0.25 for production.

Upon Failure, Replace Standard Fluorescent Fixture Ballasts with Energy-Efficient Types

Currently, fluorescent fixtures at Watervliet Arsenal use standard-efficiency ballasts. When a failure occurs, the standard ballast should be replaced with an electronic ballast. Energy savings for two lamp fixtures are 25 watts for four-foot models and 45 watts for the eight-foot type. Paybacks vary from 0.4 years in production areas to about 1.2 years in non-production.

Increase Boiler Condensate Return

A review of boiler logs shows that the condensate return for the main boiler plant averages about 60 percent. During our site surveys, a number of steam leaks and failed traps were found that can account for much of this. Locations are listed below and were identified by WVA maintenance personnel.

Buildings	Location
44	Mechanical room
34	Roof vent
40	Vent from wing near clinic
35	Roof--southwest corner
35	Exterior well south-middle
88	Roof vent--northwest corner

110	Roof vent--northwest side
110	Roof vent--southeast side
110	Roof vent--west middle
20	Roof vent--south side

Improving the condensate return to 90 percent is an achievable goal. This would require an increase in staffing at least on a temporary basis or utilizing a contractor. Annual savings of 7,100 MBtu of fuel oil costing $47,000 could be realized.

Repair Compressed Air Leaks

Throughout the production buildings, compressed air leaks were found. Generally, the leaks occur at fittings or filters. Also, many hose attachments have been made using screw-clamps. These are not recommended as they have a tendency to cut into the hose which is carrying 100 psi air. Many leaks and clamps were identified by WVA maintenance personnel. Repairing one compressed air leak saves about 6,300 kWh (22 MBtu) of electricity each year costing $440.

5.0 ENERGY PLAN

5.1 Project Packaging

The ECOs listed in Table 4-2 were evaluated for appropriate funding category. The project scope of work listed the following guidelines on this subject.

	Project Cost	Simple Payback
QRIP	\$5,000-\$100,000	≤ 2 yrs.
OSD PIF	> \$100,000	≤ 4 yrs.
PECIP	> \$100,000	≤ 4 yrs.
ECIP	> \$200,000	≤ 10 yrs., SIR > 1.0
MCA	> \$200,000	≤ 25 yrs., ≥ 8 yrs.

DA Form 1391 is required only for those ECIP and MCA projects costing greater than \$200,000. Otherwise, DA Form 5108-R from AR 5-4 is used.

Table 5-1 contains the results of the analysis with the project funding category listed in the far right column and is summarized in Table 5-2. Table 5-3 lists the ECOs by project funding category.

Three projects, ECO 13, Reduce Air Flow; ECO 16, Return Air System; and ECO 19, Occupancy Sensor have paybacks less than four years, but do not meet the project cost minimum. Projects 8C, 8D and 8H are being funded in favor of 8A, 8B, 8E, 8F and 8G. ECO 2, Natural Gas Switch, qualifies for ECIP funds, but is likely to be funded by Niagara-Mohawk Power Company. Cogeneration, ECO 3, qualifies for ECIP funding, but requires further study due to the large cost, \$1.3 million. It also requires the natural gas line to be completed to the main boiler plant (ECO 2). Project 15, EMCS, does not meet ECIP requirements, but could be funded under MCA.

5.2 Energy and Cost Savings

Energy and cost savings for the recommended project funding are listed in Table 5-4. Project capital costs are escalated at 4 percent per year according to the project implementation schedule as discussed below. Energy costs are in constant dollars using FY 92 prices. The implementation of all projects yield a total annual energy savings of 45,900 MBtu and annual cost

Table 5-1. ECO Evaluations - Project Funding - Prioritized by Simple Payback

No.	ECO #	Project Name	Construction Cost Plus SIOH	Savings (Increase), MBtu/Year				Net Annual Cost Savings	SIR	Simple Payback (yrs)	Project Funding
				Elec	Dist	Resid	N Gas				
1	5	Elec. Demand Peak Reduction	$0	0	0	0	0	$151,000	∞	0	
2	6	Condensate Return	$16,712	0	0	2,255	3,205	$23,300	24.1	0.8	QRIP
3	12	Natural Gas Boilers	$47,268	2,497	0	0	(3,122)	$37,800	10.7	1.3	QRIP
4	13	Air Flow Reduction	$969	31	0	25	0	$740	11.4	1.4	NF
5	4	Dip Tank Covers & VSDs	$202,576	2,707	0	21,650	0	$141,900	11.6	1.5	OSD PIF
6	8A	34 W FL-Prod	$2,065	51	0	0	0	$970	6.8	2.2	NF
7	19	Occupancy Sensors	$11,976	211	0	0	0	$4,600	5.5	2.8	NF
8	10	High-Efficiency Motors	$111,227	1,602	0	0	0	$32,600	4.2	3.6	OSD PIF
9	16	Return Air System	$66,495	0	0	3,985	0	$17,500	4.6	4.0	NF
10	8H	60W FL-Prod	$367,198	4,478	0	0	0	$91,200	3.6	4.3	ECIP (2)
11	8C	T8 FL&EB-Prod	$10,490	117	0	0	0	$2,400	3.3	4.7	ECIP (2)
12	1	Power Factor Improvement	$138,786	0	0	0	0	$31,000	3.1	4.7	NF
13	8D	34W FL-NonProd	$52,591	589	0	0	0	$11,300	3.1	4.9	ECIP (2)
14	8G	60W FL-Prod	$64,691	768	0	0	0	$13,200	3.0	5.2	NF
15	2	Natural Gas Fuel Switch	$364,051	0	0	278,000	(278,000)	$66,700	4.4	5.8	NF
16	8B	34 W FL&EB-Prod	$12,299	102	0	0	0	$2,000	2.6	6.1	NF
17	8J	60W FL&EB-NonProd	$60,651	339	0	0	0	$7,100	1.7	9.0	NF
18	3	Cogeneration	$1,303,232	0	0	28,400	(77,700)	$140,500	1.0	9.8	NF
19	18	Storm Windows (1)	$107	0.02	0	2.55	0	$11	1.8	10.5	NF
20	8I	60W FL-NonProd	$108,685	58	0	0	0	$15,500	1.4	11.2	NF
21	15	EMCS	$522,900	0	0	9,851	0	$49,600	1.1	11.2	MCA
22	8F	T8 FL&EB-NonProd	$361,167	1,399	0	0	0	$30,600	1.3	12.5	NF
23	8E	34W FL&EB-NonProd	$316,753	1,104	0	0	0	$24,900	1.3	13.4	NF
24	14	High-Efficiency Chiller	$141,184	363	0	0	0	$7,400	0.8	20.2	NR
25	17	Double-Pane Wind. (1)	$495	0.02	0	2.55	0	$12	0.5	45.9	NR
26	9	Not Used	--	--	0	0	0	--	--	--	--
27	11	Boiler O2 Trim Controls	--	--	--	--	--	--	--	--	--
28	7	Condenser Fan VSDs	--	--	--	--	--	--	--	--	--

Note : VSD = Variable speed drive
FL = Fluorescents
EB = Electronic ballasts
Prod = Production areas
NonProd = Non-production areas
NF = Does not meet funding requirements

NR = Not recommended
T8 = T8 fluorescent
(1) Per unit basis
(2) Combined into a single ECIP

Table 5-2. ECO Evaluations - Project Funding Summary - Grouped by Funding Category

No.	ECO #	Title: ECO Names	Construction Cost Plus SIOH	SIR	Simple Payback (yrs)	Project Funding
1	5	Elec. Demand Peak Reduction	$0	∞	0	--
2	6	Condensate Return	$16,712	24.1	0.8	QRIP
3	12	Natural Gas Boilers	$47,268	10.7	1.3	QRIP
4	4	Dip Tank Covers & VSDs	$202,576	11.6	1.5	OSD PIF
5	10	High-Efficiency Motors	$111,227	4.2	3.6	OSD PIF
6	8C	T8 FL&EB-Prod	$10,490	3.3	4.7	ECIP (1)
7	8D	34W FL-NonProd	$52,591	3.1	4.9	ECIP (1)
8	8H	60W FL-Prod	$367,198	3.6	4.3	ECIP (1)
9	15	EMCS	$522,900	1.1	11.2	MCA
10	1	Power Factor Improvement	$138,786	3.1	4.7	NF
11	2	Natural Gas Fuel Switch	$364,051	4.4	5.8	NF
12	3	Cogeneration	$1,303,232	1.0	9.8	NF
13	8A	34 W FL-Prod	$2,065	6.8	2.2	NF
14	8B	34 W FL&EB-Prod	$12,299	2.6	6.1	NF
15	8E	34W FL&EB-NonProd	$316,753	1.3	13.4	NF
16	8F	T8 FL&EB-NonProd	$361,167	1.3	12.5	NF
17	8G	60W FL-Prod	$64,691	3.0	5.2	NF
18	8I	60W FL-NonProd	$108,685	1.4	11.2	NF
19	8J	60W FL&EB-NonProd	$60,651	1.7	9.0	NF
20	13	Air Flow Reduction	$969	11.4	1.4	NF
21	16	Return Air System	$66,495	4.6	4.0	NF
22	19	Occupancy Sensors	$11,976	5.5	2.8	NF
23	18	Storm Windows (2)	$107	1.8	10.5	NF

Note : VSD = Variable speed drive
FL = Fluorescents
EB = Electronic ballasts
Prod = Production areas
NonProd = Non-production areas
NF = Does not meet funding requirements
NR = Not recommended

T8 = T8 fluorescents
(1) Combined into a single ECIP
(2) Per unit basis

Table 5-3. Project Funding List

Funds	ECO #	Project Description
QRIP	6	Condensate Return
	12	Natural Gas Boilers
OSD PIF	4	Dip Tank Covers and Variable-Speed Drive
	10	High-Efficiency Motors
ECIP	8	High-Efficiency Lighting
MCA	15	EMCS

Table 5-4. Energy and Cost Savings for Recommended Projects

#	Project Names	Construction Cost Plus SIOH (1)	Annual Energy Savings (MBtu/Yr)	Annual Energy Savings $(2)	Project Type	Year
5	Peak Demand Reduction	$0	0	$151,000	--	FY92
6	Condensate Return	$16,700	5,460	$23,300	QRIP	FY93
12	Natural Gas Boilers	$47,300	(625) (3)	$37,800	QRIP	FY93
4	Dip Tank Covers and VSDs	$202,600	24,357	$141,900	OSD PIF	FY93
10	High-Efficiency Motors	$111,200	1,602	$32,600	OSD PIF	FY93
8C, D, H	High-Efficiency Lighting	$430,300	5,184	$104,900	ECIP	FY96
15	EMCS	$522,900	9,851	$49,600	MCA	FY96
2	Natural Gas Fuel Switch	$364,100	0	$66,700	(4)	FY93
	TOTALS	$1,695,100	45,829	$607,800		

(1) Escalated to year of implementation.
(2) Energy costs are in constant FY92 dollars.
(3) Cost savings come from fuel switch from electricity to natural gas.
(4) Proposed to be funded by Niagara-Mohawk Power Corporation.

savings equal to $607,800, which represents a reduction of eight percent and ten percent, respectively in energy use and cost when compared to FY 91 values. Figures 5-1 through 5-4 show energy use and cost at WVA before and after implementation of these projects. Note that about $700,000 of the utility cost decrease is due to the large drop in the price of No. 6 fuel oil between FY 91 and FY 92.

5.3 Project Schedule

Project implementation dates are estimated as follows:

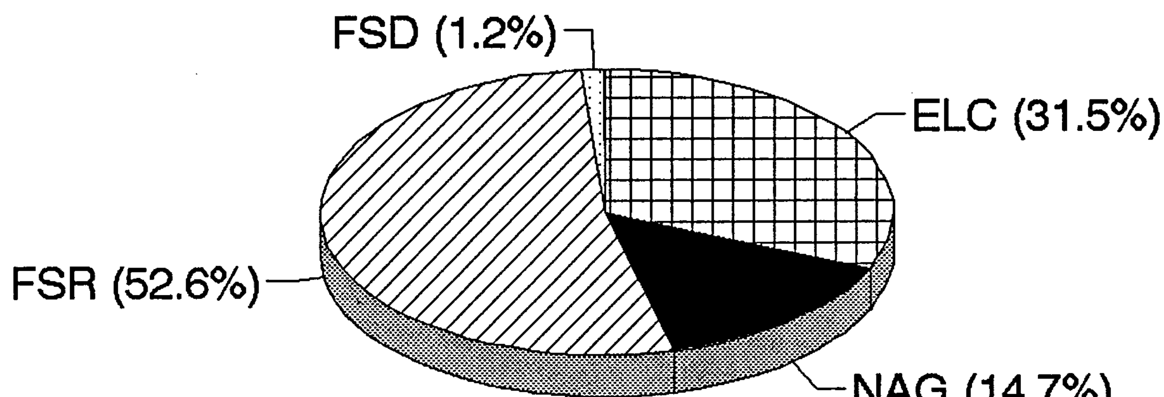
QRIP, OSD PIF	FY 93
ECIP, MCA	FY 96

Following this schedule, Figures 5-5 and 5-6 show how implementation of the recommended projects reduce energy use and cost, respectively, at WVA.

5.4 Environmental Impact

Another benefit of reducing energy use is the accompanying reduction in emissions from heating plants and electric utilities. Table 5-5 contains the results of an analysis performed using emission data collected from engineering periodicals and Niagara-Mohawk Power Corporation. When all projects are implemented, the reduction of emissions in the atmosphere are over 10,000 tons each year.

Watervliet Arsenal
FY91 Facility Energy Use

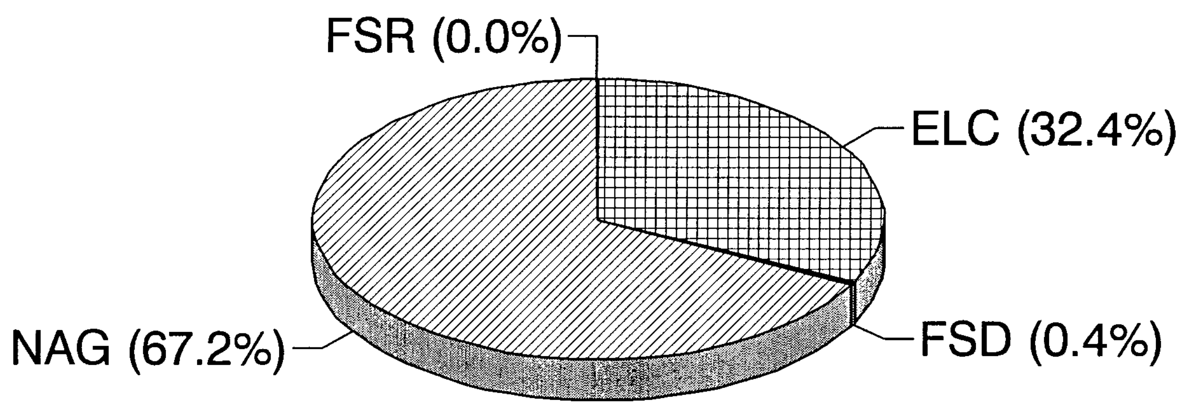


Total Use = 571,000 MBtu

Figure 5-1

Watervliet Arsenal

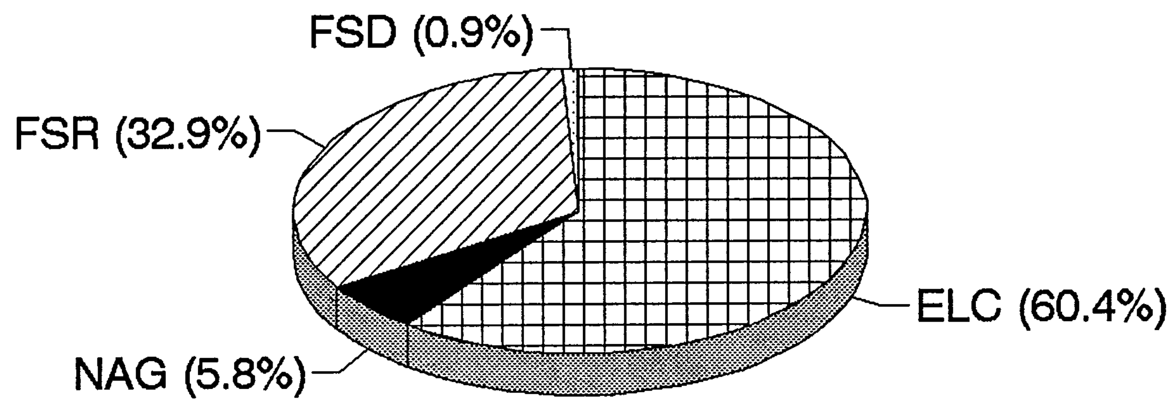
Energy Use After Project Implementation



Total Use = 525,000 MBtu

Figure 5-2

Watervliet Arsenal
FY91 Facility Energy Cost

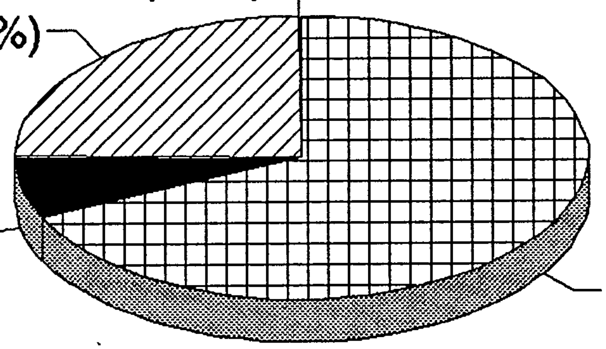


Total Cost = $ 6,024,000

Figure 5-3

Watervliet Arsenal

Energy Cost Aft. Project Implementation



Total Use = $ 4,700,000

Figure 5-4

Watervliet Arsenal
Effects of Energy Projects

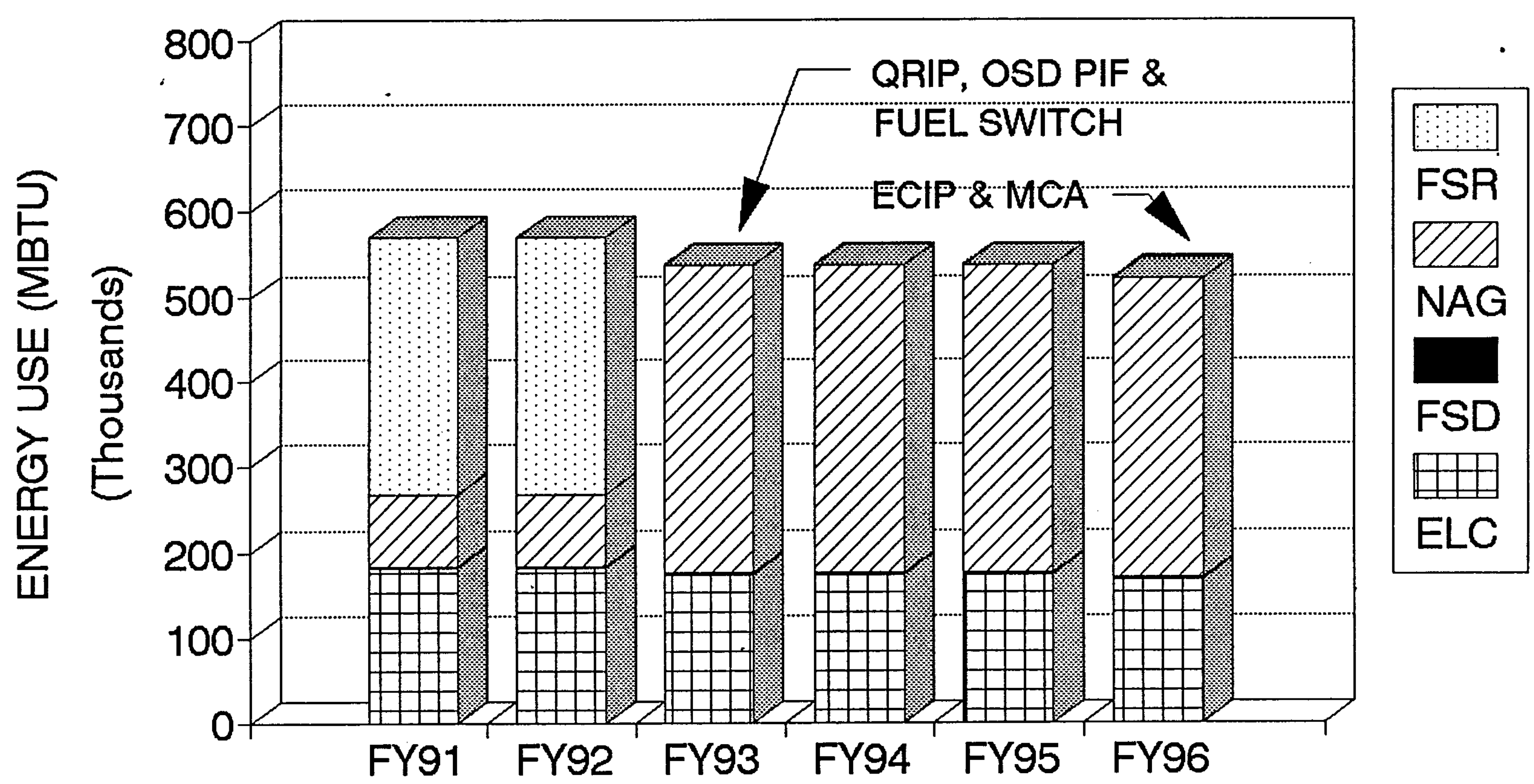


Figure 5-5

Watervliet Arsenal
Effects of Energy Projects

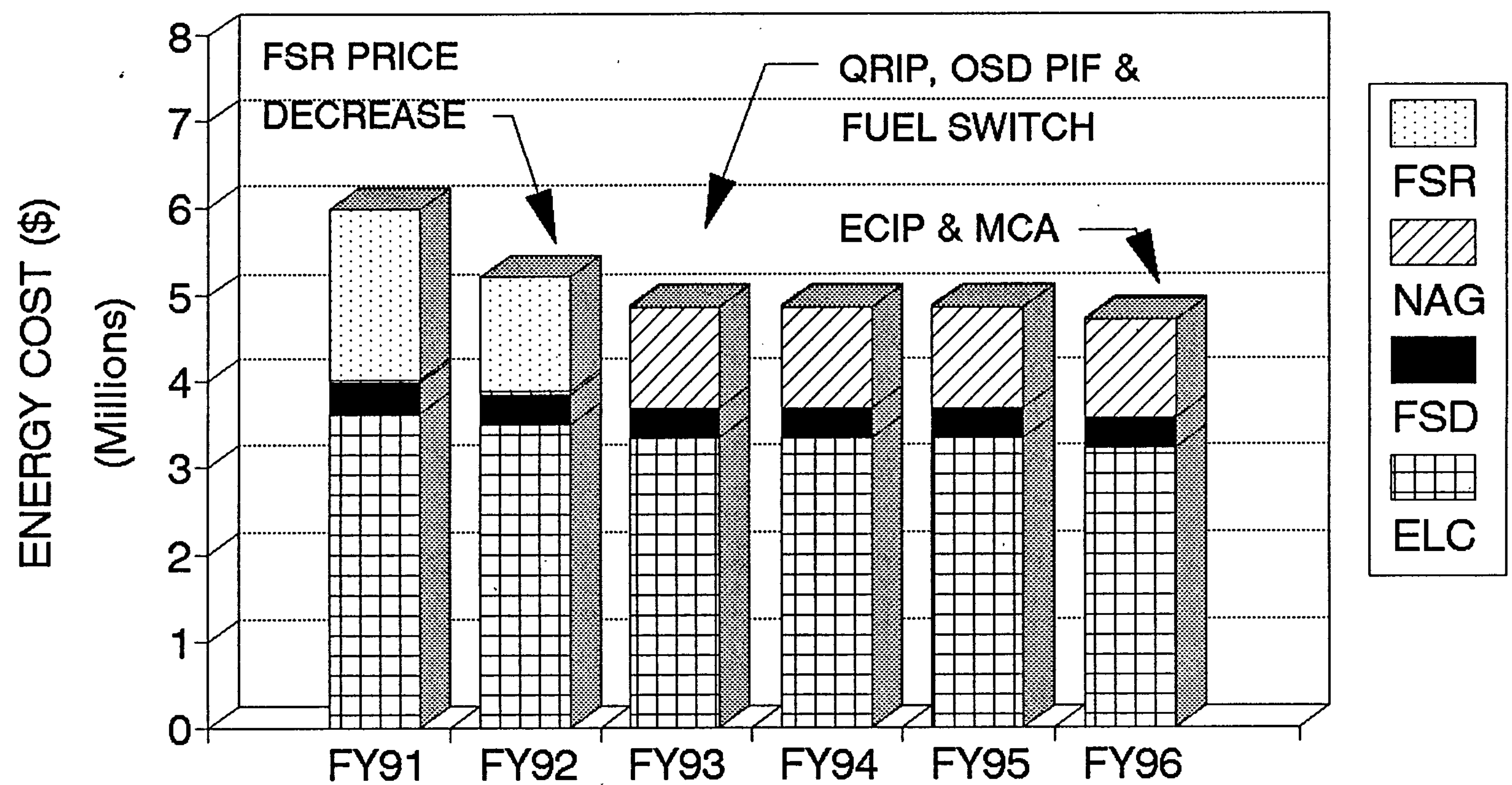


Figure 5-6

Table 5-5 Emission Reductions Due to Energy Saving Projects

ECO #	Project Name	Emissions (lbs/yr) SO2	NOx	Part.	CO2
6	Condensate Return	2,400	1,500	200	733,600
12	Natural Gas Boilers	8,800	700	700	871,100
4	Dip Tank Covers & VSDs	32,900	7,900	2,700	4,975,500
10	High Efficiency Motors	5,600	900	500	779,200
8C,D,H	High Efficiency Lighting	18,200	3,000	1,500	2,521,400
15	EMCS	10,600	2,900	900	1,664,800
5	Peak Demand Reduction	0	0	0	0
2	Natural Gas Fuel Switch	300,200	11,100	25,000	16,402,000
	TOTALS (lbs/yr)	378,700	28,000	31,500	27,947,600
	TOTALS (tons/yr)	200	14	16	14,000

SO2 - Sulfur Dioxide
NOx - Nitrogen Oxides
Part. - Particulates
CO2 - Carbon Dioxide

1.0 INTRODUCTION

1.1 Authorization

The Energy Engineering Analysis Program (EEAP), Limited Energy Study (LES), Watervliet Arsenal (WVA), Watervliet, New York was authorized by the Department of the Army, Norfolk District Corps of Engineers, under Contract Number DACA65-91-C-0072.

1.2 Objectives

The objectives of this contract, as explained in the Detailed Scope of Work (Appendix A in Volume II) of the contract are as follows:

A. Review, use and incorporate applicable data and results of the previously completed Energy Engineering Analysis Program study.

B. Perform a limited site audit and analysis of the industrial facility.

C. Re-evaluate specific projects or ECOs from the previous study to determine its economic feasibility based on revised criteria, current site conditions and technical applicability. However, no previously identified process energy-related projects or ECOs were selected by Watervliet Arsenal.

D. Evaluate specific ECOs to determine their energy savings potential and economic feasibility as indicated in the Appendix of the Scope of Work.

E. Prepare programming and implementation documentation for all justifiable ECOs.

F. Prepare a comprehensive report which will document the work accomplished, the results and the recommendations.

WVA personnel participated in the formulation of the Detailed Scope of Work by making recommendations for new ECOs, ECO updates and buildings to be surveyed. No ECOs from the previous EEAP were selected for updating. The specific new ECOs to be evaluated are:

1. Power factor correction

2. Fuel switch from No. 6 fuel oil to natural gas in the main boiler plant (Building 136)
3. Cogeneration
4. Reduce heat loss in dip tank operators (Building 35)
5. Electrical demand peak reduction
6. Improve steam distribution and condensate return system

The following buildings were selected for the site survey:

35	Medium Caliber Tube
110 (South end)	Preservation and Packaging
125	Breech Components and Weld Shop
135	Heavy Caliber Tube

In October of 1991, Option 1--Ancillary Facilities was authorized by the Norfolk District COE. This option expanded the energy study to include 17 additional buildings which are generally non-production facilities. They are listed below.

10	Campbell Hall
15	Garage (Motor Pool)
20	Major Component Building
21	O'Keefe Hall
22	Fire Station
23	Operations Office
24	Operations Office
25	Minor Comp. Bldg. & Op. Offices
38	Storehouse and Museum
40	Benet Labs & Others
44	Dalliba Hall/Product Assurance
110	(Remainder) Heavy Caliber Tube Bldg.
115	Maggs Research Center
120	Facilities Offices and Shops
130	Storehouse/Processing Bldg.
136	Boiler Plant
145	Warehouse & Property Disposal

1.3 Phases of Work

The work to be performed under the contract has been divided into three phases:

- o Phase I--Field Investigation and Data Gathering.
- o Phase II--Data Analysis. Analysis of data, identification of potential projects, performance of feasibility and economic studies and preparation of Life Cycle Cost Analysis forms. During this phase, all potential projects which produce energy and/or dollar savings will be identified and evaluated as to their technical and economical feasibility. Project will be ranked according to the highest saving investment ratio (SIR) value.
- o Phase III--Report Preparation. Complete documentation of work accomplished. Project documentation for all justifiable ECOs.

1.4 Submission Requirements

Because of the contract modification to include Option 1--Ancillary Facilities, the study is now divided into three submissions.

A. Interim
B. Prefinal
C. Final Report

1.5 Work Accomplished

An entrance meeting was held on June 17, 1991 with the Chief of the Engineering Plans and Services, the Production and Facilities Energy Coordinators, and other energy office personnel to discuss the scope of work, current energy initiatives at WVA and work plans and schedules for the field survey.

Field surveys of the industrial facilities were performed from June 17, 1991 to June 21, 1991. During that time, a team of engineers from Reynolds, Smith and Hills, Inc. (RS&H) performed tests, observations and interviews with operating and maintenance personnel in industrial processes.

The exit meeting was held with the Installation Commander, plus Production and Facilities Energy Coordinators on June 21, 1991.

Since that time, work has been performed in the analysis and documentation phases of the project. This included ECO evaluation, Life Cycle Cost Analysis, and documentation of the results and site survey observations. The results of these efforts formed the Interim Submittal.

Field surveys of the Ancillary Facilities were performed from October 15 to October 18, 1991 and December 18, 1991 through December 20, 1991. A presentation of the results to date was given to Watervliet management on December 18, 1991.

To minimize the amount of paperwork, the two contract parts--the industrial facilities and the ancillary facilities--were combined into a single set of documents. Both the Prefinal and the Final Reports were submitted in this format.

Presentation of the Final Report was made at WVA on September 10, 1992.

1.6 Report Organization

The report consists of six volumes. Volume I, the Narrative Report, contains the results of all of the site surveys, analysis and project development. All backup data and calculations are found in Volume II. The site survey notes are in Volumes III (Production Facilities) and IIIa (Ancillary Facilities), and project documentation forms necessary for receiving funding are in Volume IV. Also included is an Executive Summary volume.

Volume I is the Narrative Report and its organization is explained here. Following a brief introduction in Section 1.0, the existing conditions at WVA are discussed in Section 2.0. This includes a description of the installation, current and past energy use patterns, and a review of previous energy studies. Section 3.0 describes the techniques used to perform this study. Section 4.0 contains the results of the analysis of the energy conserving opportunities (ECOs). The ECO Implementation Plan and the effects on energy use at WVA are located in Section 5.0.

2.0 EXISTING CONDITIONS

2.1 Installation Description

Watervliet Arsenal (WVA) is a government-owned, government-operated (GOGO) production facility under AMC direction. The Arsenal's mission is to manufacture cannons, special tools, test equipment, and training devices needed to support large caliber weapons. The facility is equipped to produce cannons with bore diameters from 20mm to 16 inches. WVA is also the home of Benet Weapons Laboratory, active in weapons-related research, development and processes. The installation site plan is contained in Figure 2-1.

There are 80 buildings at the Arsenal, representing over two million square feet of space. Most buildings are dedicated to manufacturing and administration.

2.2 Facility Descriptions

2.2.1 Production Facilities. The basic process flow diagram between the buildings surveyed are shown in Figure 2-2. The raw materials for making the major gun tube components, minor gun tube components, other components, and gun tubes are brought to Buildings 20, 25, 125 and 135, respectively. Building 35 receives the gun tube and other components in a rough form, and various other machining operations as well as plating are performed here. The final step in the process is performed in Building 110 where the assemblies are painted, preserved and packaged for shipment. These buildings represent 1.2 million square feet, about 60 percent of the installation total.

Building 20

Building 20 is a multi-storied building housing both administrative and process functions for WVA. The building's floor space totals 107,157 square feet, the majority of which is a high-bay area devoted to the machining of major cannon components. Process equipment consists of tools required for the machining of large components, such as large mills, lathes, grinders, etc., much of which is automated.

Electricity is the only type of energy used to power the processes housed in the building. The electric motors are generally integrated into the

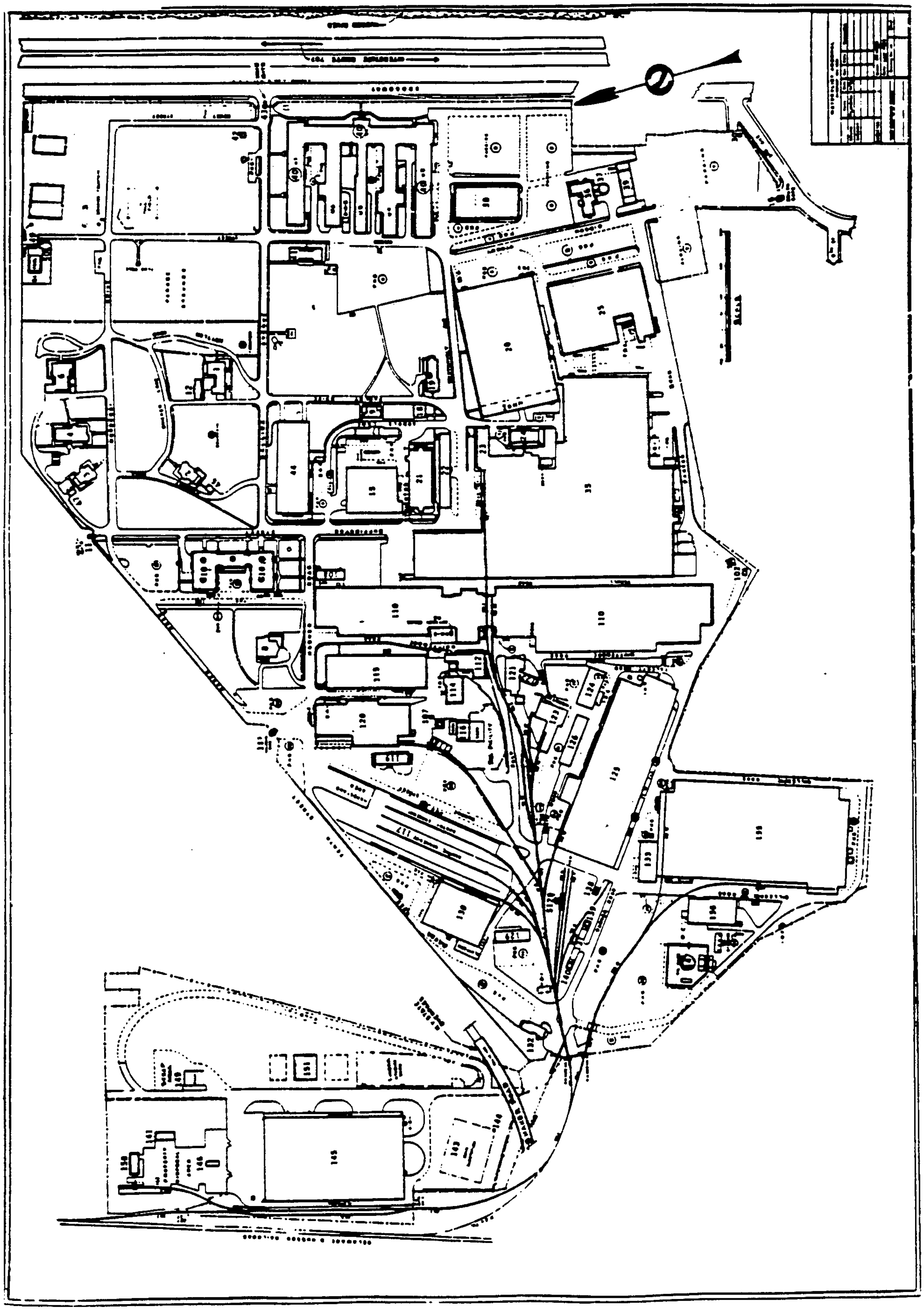


Figure 2-1
Watervliet Arsenal Site Map

Watervliet Arsenal

Basic Process Flow Diagram

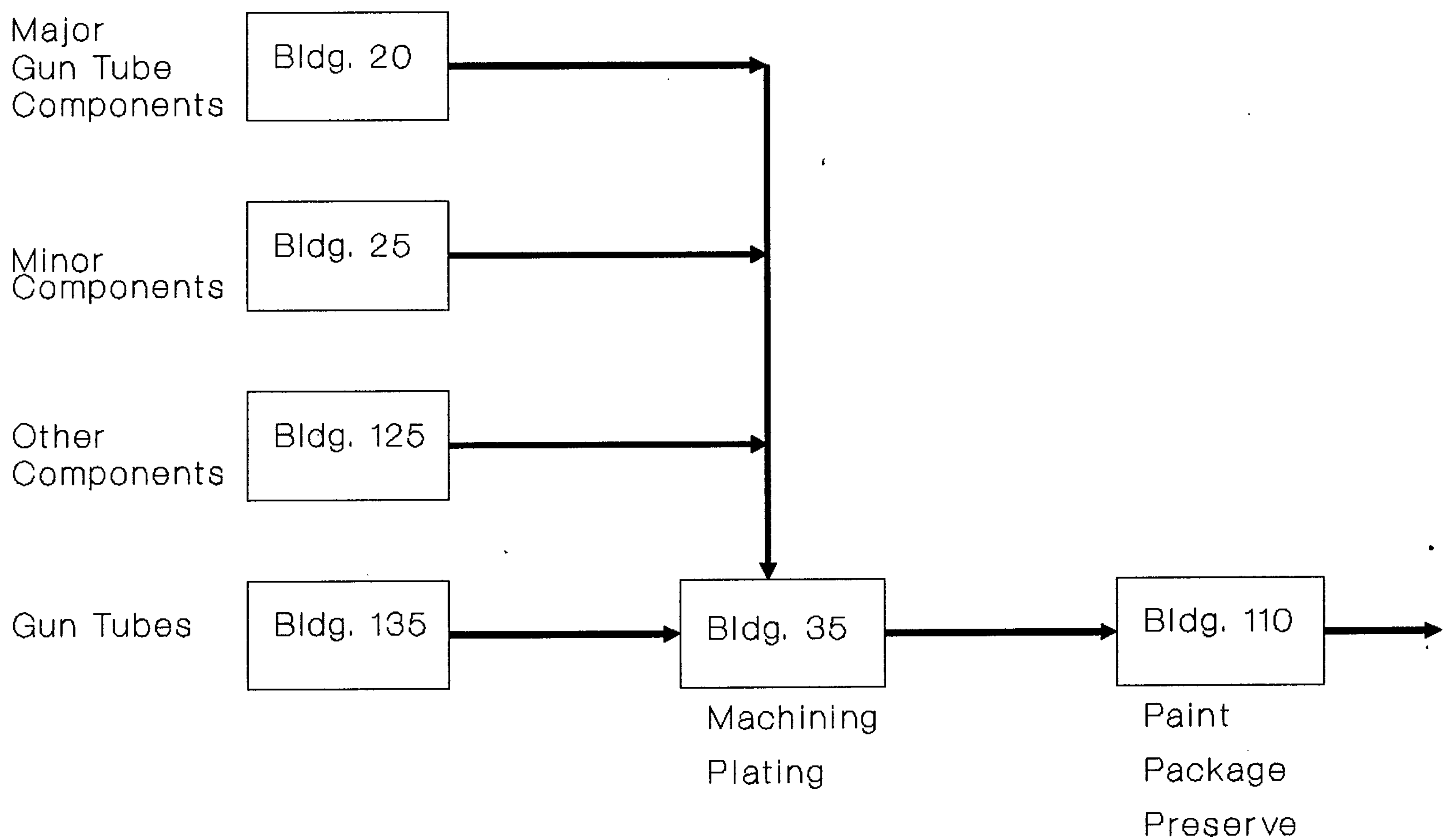


Figure 2-2

machinery. Lighting of the process area is done with 84- or 90-watt fluorescent bulbs, housed in fixtures containing two bulbs each. The fixtures do not have efficient reflective properties.

Building 25

Like Building 20, Building 25 is a multi-storied building housing both administrative and process functions for WVA. The building's floor space totals 185,886 square feet, with the bottom two floors devoted to the machining of various minor components of the cannons. Process equipment consists of tools required for the machining of small components, such as mills, lathes, grinders, etc., plus hand-held tools.

Electricity is the only type of energy used to power the processes housed in the building. The electric motors are generally integrated into the machinery. Lighting of the process area is done with 110-watt fluorescent bulbs, housed in fixtures containing two bulbs each. The fixtures do not have efficient reflective properties.

Building 125

Building 125 houses the shops that are used for Arsenal welding and fabrication services, including the first four roughing operations to form the breech block of the 120-millimeter cannon. The building is single-story and has floor space of 119,200 square feet. Process equipment consists of milling machines, grinding machines, turning machines, rollers, presses, shears, a number of welding machines (approximately 20), and three electric furnaces that are used either to preheat substances for welding or to relieve stress in formed materials.

Electricity is the only type of energy used to power the processes housed in the building. The electric motors are generally integrated into the machinery. Lighting of the process area is primarily done with high-pressure sodium lamps.

The main power draw for individual machines is from the three furnaces. The maximum power draws are 75kW, 123kW and 217kW, respectively. The largest furnace is reported to be used at night, whenever scheduling permits, in order to take advantage of lower electric rates.

Building 135

The manufacture of heavy caliber (105mm, 120mm and 155mm) cannon tubes begins in Building 135. The five major processes within this building are:

- o Rotary Forge
- o Continuous Heat Treat
- o Machining
- o Swage
- o Machining

Rotary Forge

The rotary forge process (refer to Figure 2-3) starts with a steel pre-form tube supplied by an outside vendor. The pre-form is heated to 2200°F in one of the five Tocco electric induction furnaces. Each furnace draws approximately 1250 kW for the first 20 minutes and 625 kW for another one hour and ten minutes. The induction coils of the furnaces are cooled with water circulated through a dedicated cooling tower. When the pre-form reaches the desired temperature, it is transported to the rotary forge where it is forged to the required specifications for 105mm, 120mm or 155mm tubes. The forging process is completely automatic and takes about 20 minutes. After forging, the ends of the tube are cut off using the abrasive hot saw. The tubes are then placed on racks and allowed to cool to ambient temperature.

The forging operation is very energy intensive and, according to the CERL report, <u>Process Energy Inventory at Watervliet Arsenal</u> (Section 2.4), uses about 11.2 MBtu/gun tube or 30 percent of the total process energy requirement.

Continuous Heat Treat

In order to achieve the required metal properties, the cooled forged tubes are subjected to a continuous heat treat process (refer to Figure 2-4). The heat treat process is accomplished by placing the forged tube on a continuous roller conveyor where it is carried through an austenitizing furnace, water quench and a two stage tempering furnace. The equipment for the heat treat process was manufactured by Selas. This process starts with the austenitizing furnace section which uses natural gas combustion to heat the tube to about

Watervliet Arsenal

Rotary Forge Flow Diagram

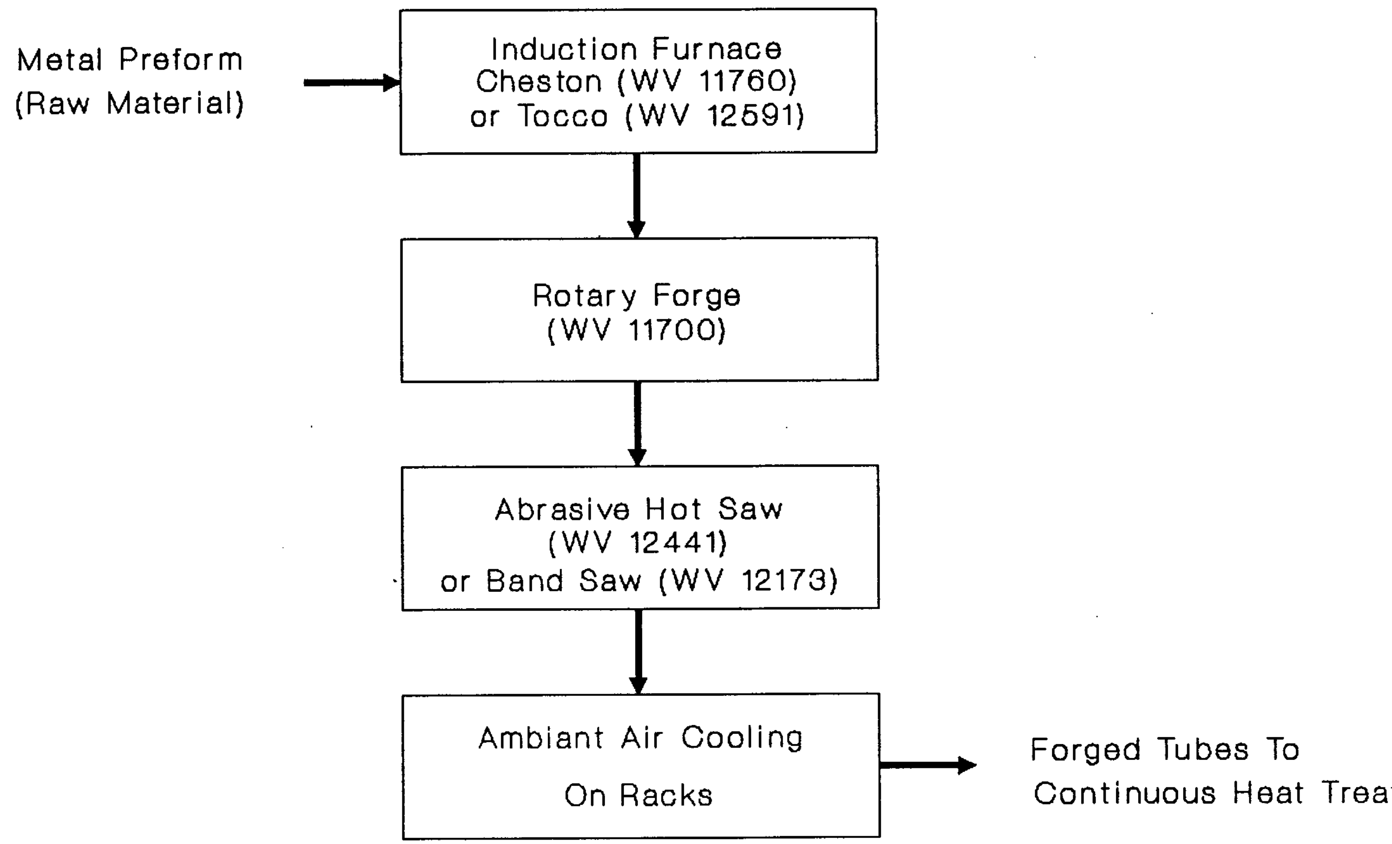


Figure 2-3

Watervliet Arsenal

Continuous Heat Treat Flow Diagram

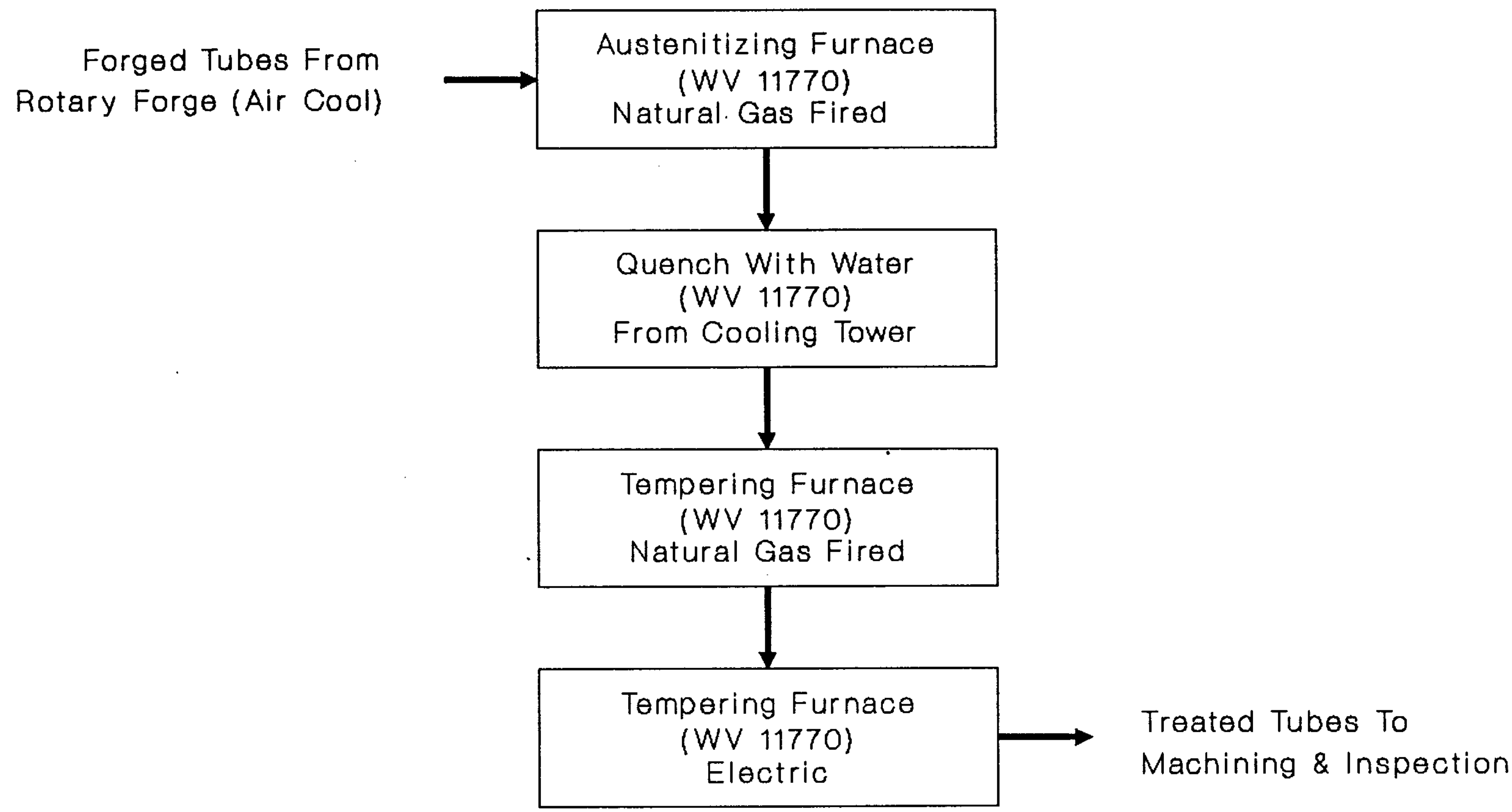


Figure 2-4

1700°F. The tube is then quenched to about 100°F with 2,550 gpm to 2,700 gpm of water which is recirculated through a cooling tower. After quenching, the tube is carried through two stages of a tempering furnace. The first stage is natural gas fired and the second stage is electrically heated. Both stages maintain approximately 1000°F. Upon removal from the tempering furnace, the tubes are placed on racks and allowed to cool to ambient temperature. The entire heat treat process takes about 7.5 hours for 105mm tubes, 11 hours for 155mm tubes and 15 hours for 120mm tubes. The heat treat system operates 24 hours per day, five days per week. It is turned on Sunday at about midnight and the start running tubes through about 0630 hours.

On a Btu basis, this is the most energy-intensive operation in making the gun tubes. CERL estimated that 17.6 MBtu per gun tube is consumed in this process. This represents 47 percent of the total process energy requirement.

Machining and Inspection

Initial machining of the tubes (refer to Figure 2-5) begins after the heat treat process. The first machining operation uses a press to straighten the tube. The next two operations use lathes to smooth the outside diameter of the tube. The inside diameter of the tube is then bored using a lathe and finished with a hone. After these machining operations, the tubes are inspected for correct size and material properties.

Swage

The swage process (refer to Figure 2-6) is used to harden the inside diameter of the cannon tubes by "cold working." The first step is to clean and grease the inside of the tubes. Next, the swage is used to push a cone shaped mandrel (which has a outside diameter that is slightly larger than the inside diameter of the cannon tube) through the tube. The tubes are then placed in an electrically heated vertical furnace and heated for approximately 12 hours. This relieves the stresses that are built up during the swage process. Upon removal from the vertical furnace, the tubes are placed on racks and allowed to cool to ambient temperature.

Watervliet Arsenal

Machining & Inspection Flow Diagram

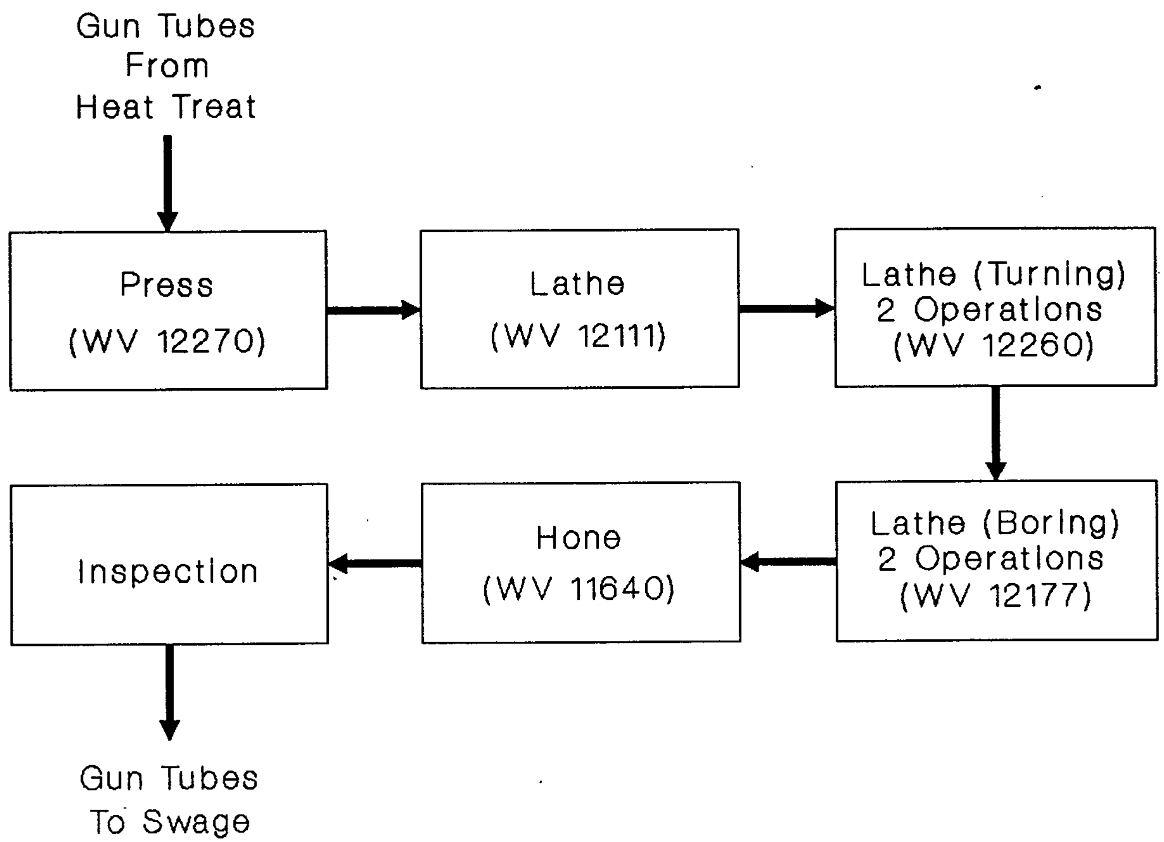


Figure 2-5

Watervliet Arsenal

Swage Flow Diagram

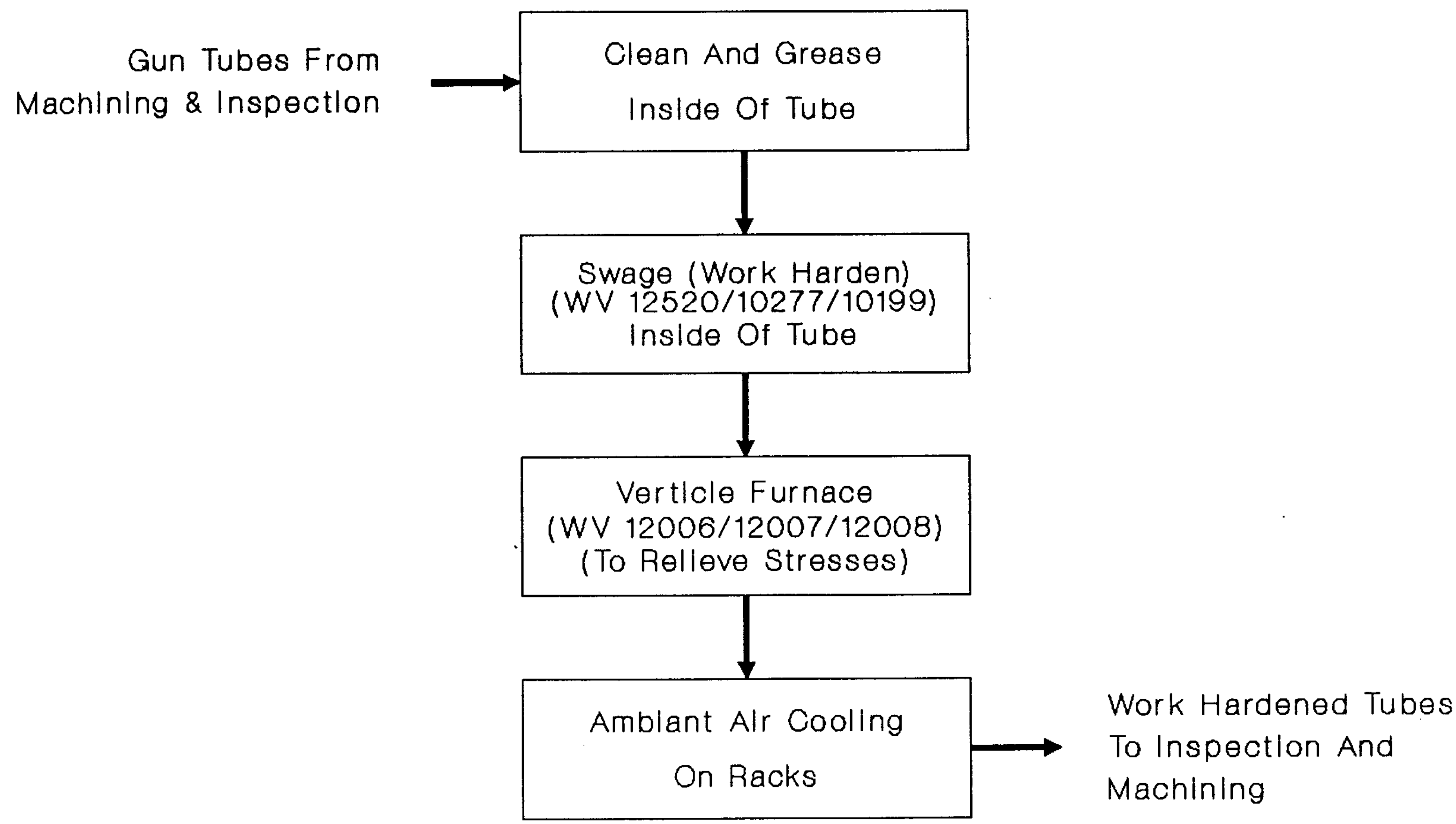


Figure 2-6

Inspection and Machining

Final machining of the tubes (refer to Figure 2-7) occurs after the swage process. After the tubes are air cooled, they are inspected for correct size and material properties. A series of machines is then used to press, bore, hone and chamber the tubes to their final dimensions. The cannon tubes are then transported to Building 35 for final machining and chrome plating.

Building 35

Final machining and plating of the gun tubes and other ancillary components are performed in Building 35. The gun tubes are received from Building 135 and other components from Buildings 20, 25 and 125. The final machining operation is a multi-step operation using about 20 different machines for such tasks as:

- Mill breech thread
- Mill breech, muzzle and slide keyways
- Grind bore chamber
- Rifle bore
- Drill evacuation chamber holes

All of these machines use electricity for system hydraulics (electric motors) and controls. Although these machines do not use large amounts of energy when compared to the rotary forge and Selas furnace, there is considerable energy wasted during machine idling. The CERL report calculated that 26 percent of the 7.7 MBtu of energy consumed in the machining process was used during idling time. At current electricity rates (6.8¢/kwh), this represents about $40 per gun tube.

Other smaller components such as the breech blocks go through a similar machining process, although much is accomplished in the completely automated Flexible Manufacturing System.

After final machining, the gun tubes and small parts go to separate plating areas. The gun tubes are chrome-plated in cylinder-shaped tanks that stand vertically. The smaller parts are plated with various coatings in rectangular tanks. Energy used in this operation is primarily electricity. During five

Watervliet Arsenal

Inspection & Machining Flow Diagram

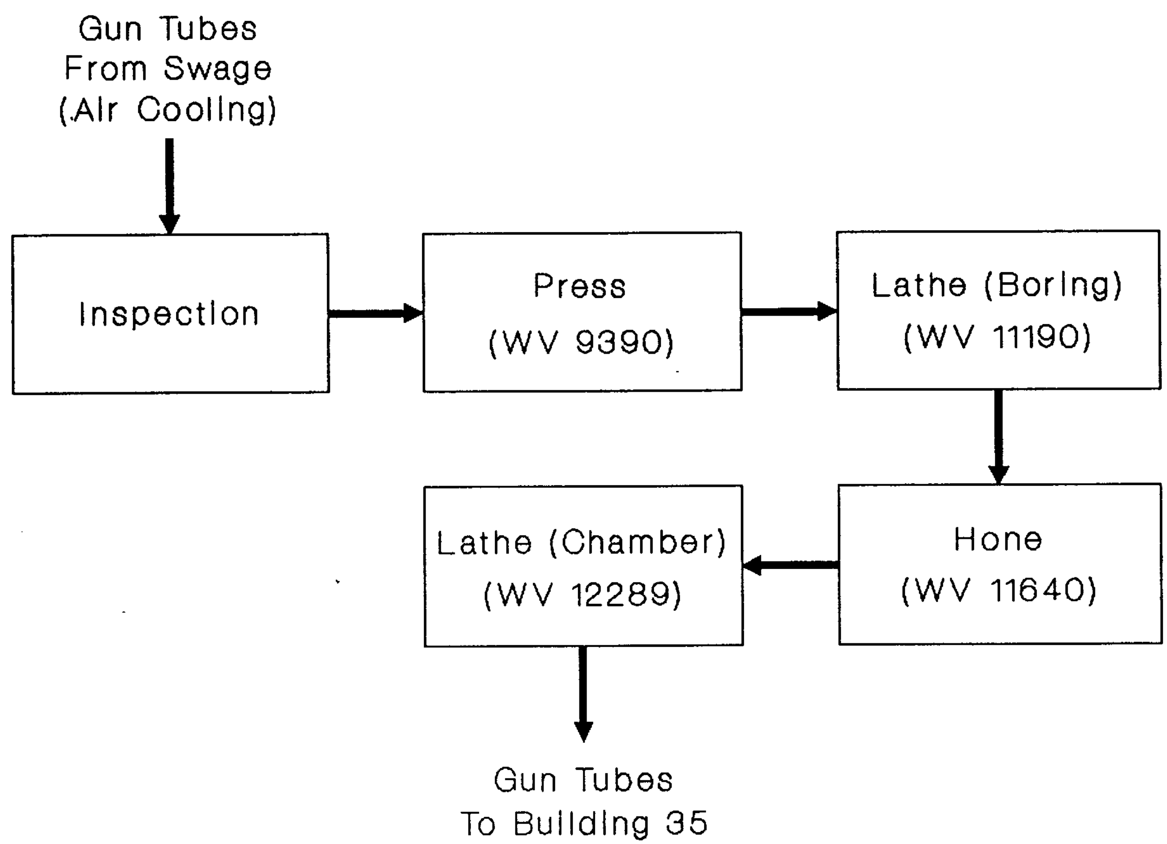


Figure 2-7

summer months, natural gas is also used in a nearby boiler to provide steam for heating some plating tanks. The CERL report calculated about 0.4 MBtu of energy is consumed per gun tube in the plating process. This is about one percent of the estimated total.

The plating process is followed by heat treating using electrical Wellman furnaces. This furnace is cylindrically shaped in a vertical position and can heat up to six tubes per cycle. The smaller components are heated in smaller, more specialized furnaces. CERL estimated 0.6 MBtu per gun tube for this process.

Major energy consumers in the plating process include the Wellman furnaces, electrical plating equipment and air exhaust system.

Building 110

The preservation and packaging processes (refer to Figure 2-7a) are located in the south end of Building 110. Cannon tubes and other parts that are ready for painting are received from Building 35. During the winter, the parts are placed in the drying booth and heated for about one hour prior to painting. Various parts and gun tubes are placed in the paint booth and painted. The paint booth operates for a total of about ten to 12 hours each day. The preservation process operates three shifts per day, five days per week. After painting, the parts are moved to the drying booth which is heated to approximately 110°F by steam or natural gas. The supervisor indicated that the drying booth heating system was rarely used; however, it was operating during the site survey. After the parts are painted and dried, they are assembled and packaged for shipment to the customer.

Building 136

Building 136 is the Arsenal's main boiler plant. It provides 135 psia steam for installation space heating and process loads for all months requiring space heating. This usually includes October through April. The summer time process heating loads are provided by a donkey boiler located adjacent to Building 35. The boiler provides steam to the plating processes in Building 35.

Watervliet Arsenal

Preservation & Packaging Flow Diagram

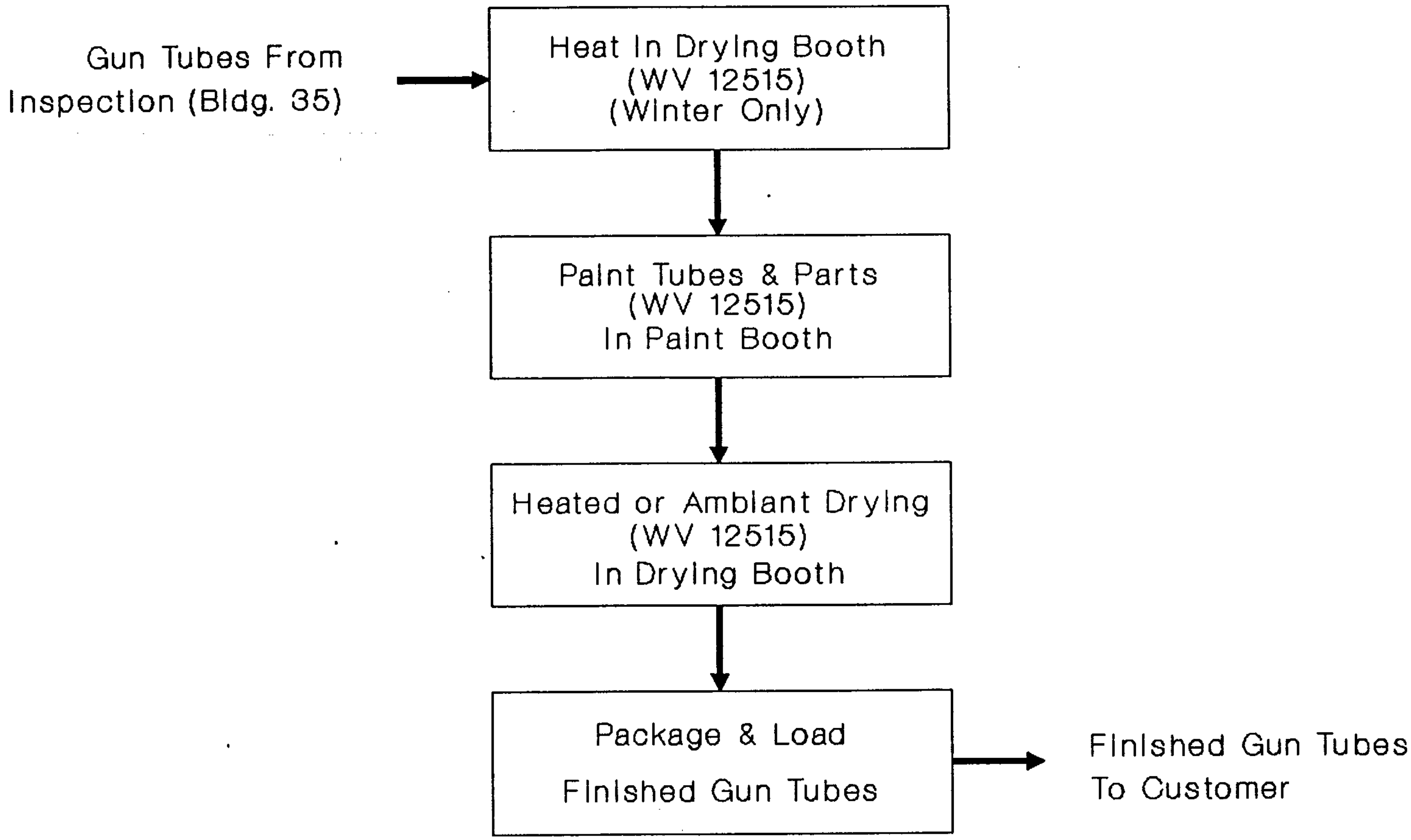


Figure 2-7a

There are five No. 6 fuel oil-fired boilers in the main boiler plant, and they are listed below:

No.	Steam Capacity (Pounds/Hour)
1	50,000
2	50,000
3	110,000
4	110,000
5	25,000

The primary boiler is No. 3. It has recently been refitted with new burner controls (including O_2 trim), dual fuel capability (fuel oil and natural gas), and new burners that allow a 10:1 turn-down ratio.

In addition, boiler No. 3 has variable speed drives on the forced draft and induced draft fans. It is estimated that the No. 3 boiler can handle 95+ percent of the maximum load at the Arsenal, and with the large turn-down ratio, cover the smaller loads in the spring and fall. The No. 5 boiler will be used only during those peak periods when loads exceed the capacity of No. 3. The No. 4 boiler will be kept as a back-up to No. 3, and Boiler Nos. 1 and 2 will be removed.

This boiler plant, including control system, is in excellent operating condition. The operating data logs are among the best ever encountered by the author. Steam production efficiency is monitored on a daily basis and is maintained in a range from 75 to 85 percent.

The only potential energy conservation options found here involve improvements to the steam distribution and condensate return systems. Currently, make-up water ranges from 30 to 50 percent, and no condensate is returned from the plating process areas in Building 35. Returning condensate from the plating areas or simply recovering the wasted heat energy are potential energy saving projects.

2.2.2 Ancillary Facilities. Ancillary facilities are defined here as non-production buildings. This includes administration, laboratories and support services as well as other non-energy-intensive buildings. All buildings are masonry typically utilizing a dark red brick. Since WVA began in 1814, there are many buildings of historical interest. All buildings surveyed, except Building 145, are heated via steam from the main boiler plant, Building 136. These buildings have a total floor space of about 900,000 square feet.

Building 10--Campbell Hall

Campbell Hall is a three-story building of masonry construction which is the location of the WVA Headquarters. It is primarily an administrative building operating five days per week from 0730 to 1600 hours. Steam from the main boiler plant provides space heating via a hot water heat exchanger. The north end of the building is air conditioned with a central chiller in the finance and accounting areas. The remainder of the building is spot-cooled with window units. Aluminum-framed storm windows have been installed over the original wood-framed windows. Many of the storm windows were found to be open, even on days when the air temperature was below 20°F. Several storm windows were broken or unusable.

Building 15--Garage (Motor Pool)

Building 15 is the location of the Transportation and Traffic Division. It is a one-story masonry building. The front part houses administrative functions, and the rear is the motor pool. The administrative area is space-cooled using a direct expansion unit. All areas are heated using steam from the central boiler plant. The office areas use convectors and in the garage, unit heaters. All windows are single-paned. The building is operated basically from 0730 to 1600, except for one individual who works from 1600 to 2400.

Building 20--Administrative Areas

This building has two floors plus a mezzanine area. The construction type is masonry with double-pane windows. Heating is provided by steam-fed convectors served by the central steam plant. The administrative areas are cooled by a rooftop packaged unit. The operating hours are 0730 to 1600. Several occupants complained of uneven heating and cooling. The downstairs area includes a snack bar.

Building 21--O'Keefe Hall

Building 21 is a one-story masonry building that serves as a cafeteria and administrative area housing Army Community Services. All but the east-facing windows have storms. Steam is supplied by the central boiler plant and feeds perimeter radiators. Operating hours are 24 hours per day.

Building 22--Fire Station

The Fire Station is a single-story masonry building with storm windows throughout. Steam is supplied to radiators via the main steam plant. The building is used 24 hours per day. Steam valving stations are located in the emergency vehicle garage area. Many of these lines were uninsulated.

Building 23--Operations Office

Building 23 is a three-story masonry building that is attached to the northeast corner of Building 35. The first and third floors are used for manufacturing. The second floor and basement house supply functions. All areas are heated by steam from the main boiler house using radiators. The third floor has manual control valves only. Only the second floor is air conditioned. Only the first floor has double-paned windows; all others are single. Operating hours for the basement, the second and third floors are 0730 to 1600. The first floor is occupied from 0730 to 2400. The basement area has a large amount of uninsulated steam lines and valves.

Building 24--Operations Office

Building 24 is a masonry building with two main floors and a basement. The building has a unique architecture that should be preserved if any work is recommended on the building exterior. The second floor is air conditioned. The main boiler plant supplies steam to convectors and radiators. The north end of the second floor was found overheated. All windows are single-pane type. The building operating hours are 0730 to 1600 except for maintenance personnel who leave at 2100 hours.

Building 25--Administrative Area

Building 25 is a three-story masonry building--the first two are production areas, and the third is administration. The administrative areas are heated and cooled. Steam is supplied from the main boiler plant and cooling is

supplied by two rooftop units. All third-floor windows are double paned. Operating hours in administrative areas are 0730 to 1600.

Building 38 Storehouse and Museum

This building is divided into two parts. The museum occupies the northern one-third of the buildings; the remainder is unheated storage. The building is made of steel with large, ornate single-pane windows. Heating is provided via steam from the main boiler plant. Only the museum is air conditioned. Operating hours are 0730 to 1600. There is also a small administrative area upstairs near the museum. Heating is inadequate there with only one convector supplying the area.

Building 40--Benet Labs

Benet Labs is a large masonry, multipurpose building with five wings extending from the main area. The main building and two outboard wings are two-story structures; the others are single-story construction. The building is being remodeled with new interior finishings, plus a hot-water heating system. The main building is air conditioned. Most areas have double-pane windows. An exception is the Foundry Wing which was very old, large single-pane types. The south wing has manually controlled steam radiators on both floors. Operating hours are 0730 to 1600. An electric boiler is located here and is used to provide humidification for the space conditioning system.

Building 44--Dalliba Hall

Dalliba Hall is the location of the Product Assurance Directorate, Information Management Directorate and Equipment Test Measurement. It is a brick, one-story building with a large basement area that is above ground on the east end. The ground floor is primarily administrative area with the exception of the Gage Checking area. This area is conditioned to maintain close tolerances on temperature and humidity. About one-fourth of the basement contains a computer facility which is heated and cooled. The remainder is used for storage plus a small preserving and packaging area. These spaces are heated only. All administrative areas have air conditioning. Operating hours are 0730 to 1600 except for a small second shift until 2400 hours. Steam is provided by the main boiler plant. An electric boiler is located in Building 44 to provide humidification for the Equipment Test areas.

Building 110

See Section 2.2.1.

Building 115--Maggs Research Center

Building 115 is a two-story masonry building. All administrative and lab areas are heated and cooled using fan coil units. Some manual-controlled radiators were found on the first floor in west side offices and east side labs. Most of the east half of the building contains a high pressure testing booths which have special cooling and heating requirements. Windows are double-pane type. Operating hours are 0730 to 1600.

Building 120--Facilities Offices and Shops

Building 120 is a three-story masonry building which is adjacent to Building 115 and is connected to it by an enclosed walkway on the second floor. The first floor contains office areas along the eastern one-fourth of the building. The remaining areas house the box shop, storage, HVAC shop and Preventative Maintenance. The second level is occupied by Benet Labs. The third is open supply, the electrical shop, secure supply and the sheet metal shop. The first-floor offices and the entire second floor is air conditioned. The building is heated with main boiler plant steam feeding forced air heat exchangers and perimeter radiation. Windows are single-pane type. Primary operating hours are 0730 to 1600. One plumber is on duty from 2400 to 0800. Many traps were found leaking past distribution downcomers causing space overheating problems, especially in the western exterior offices on the second floor.

Building 130--Storehouse

This building is a single-story masonry type with large single-pane windows. The roof is uninsulated as well as several steam lines. Heating is provided via the main boiler plant which supplies steam to unit heaters. A small section of this building is used for manufacturing. Operating hours are 0730 to 1600.

Building 136--Main Boiler Plant

See Section 2.2.1.

Building 145--Warehouse and Property Disposal

Building 145 is a single-story, concrete block facility with no windows. Steam from a local #2 fuel oil-fired boiler supplies steam to office space near the building entrance and an enclosed work area toward the rear of the building. The remainder of the building, which is used for storage, is unheated, but humidity controlled. The building is occupied from 0730 to 1600.

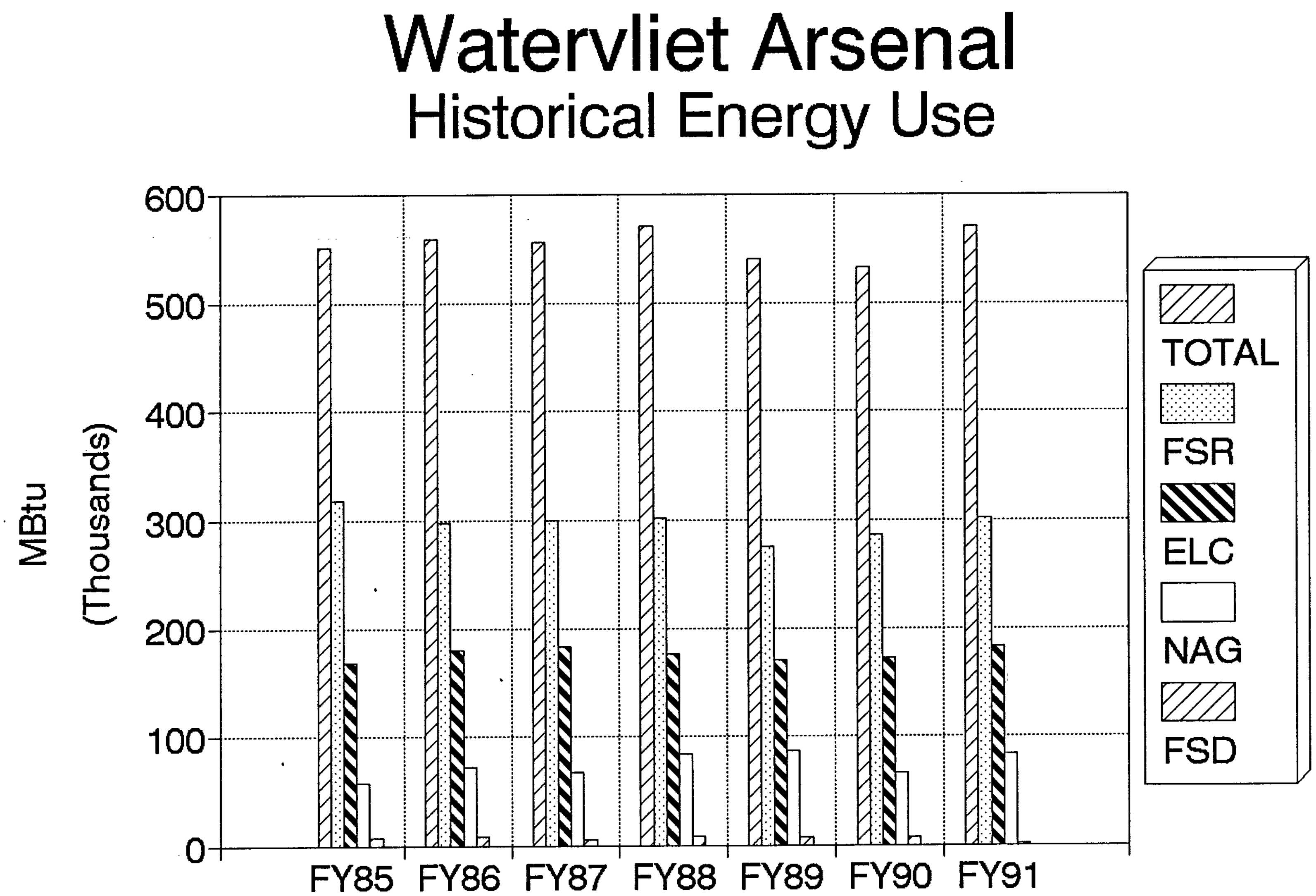
2.3 Historical Energy Use and Costs

2.3.1 Energy Use. Total facility and production energy consumption at WVA increased by approximately 3.6 percent from FY 85 through FY 91 (Figure 2-8). The cause for the increase was because of increases in the use of electricity and natural gas which increased 8.5 percent and 45 percent, respectively. Residual fuel oil and distillate consumption decreased 5.0 percent and 70 percent.

Monthly consumption of heating fuels and electricity for FY 91 is shown in Figure 2-9. The strong dependence of heating fuels on weather is readily apparent, although some steam is generated during the summer months for uses other than space heating (metal plating in Building 35). Electricity use is fairly constant throughout the year, showing that almost all electricity consumption is strictly production related.

Percentages of fuel use for FY 91 are shown in Figure 2-10. The heating fuels accounted for approximately 68 percent of energy use in that year.

2.3.2 Costs. Total annual energy costs at WVA were unusually high in FY 91, about 33 percent over the FY 85 values (Figure 2-11). The changes in costs reflect changes in unit pricing over the same time period (Figure 2-12). The main reason for the increase was the large increase in fuel oil costs due to the impact of Desert Shield in late summer 1991. Iraq occupation of Kuwait caused oil prices to skyrocket. Unfortunately, this was in the same time period that the Army negotiated its annual fuel oil contracts four all CONUS installations.



Watervliet Arsenal
Historical Energy Use
MBtu
(Thousands)
600
500
400
300
200
100
0
FY85
FY86
FY87
FY88
FY89
FY90
FY91
TOTAL
FSR
ELC
NAG
FSD

Figure 2-8

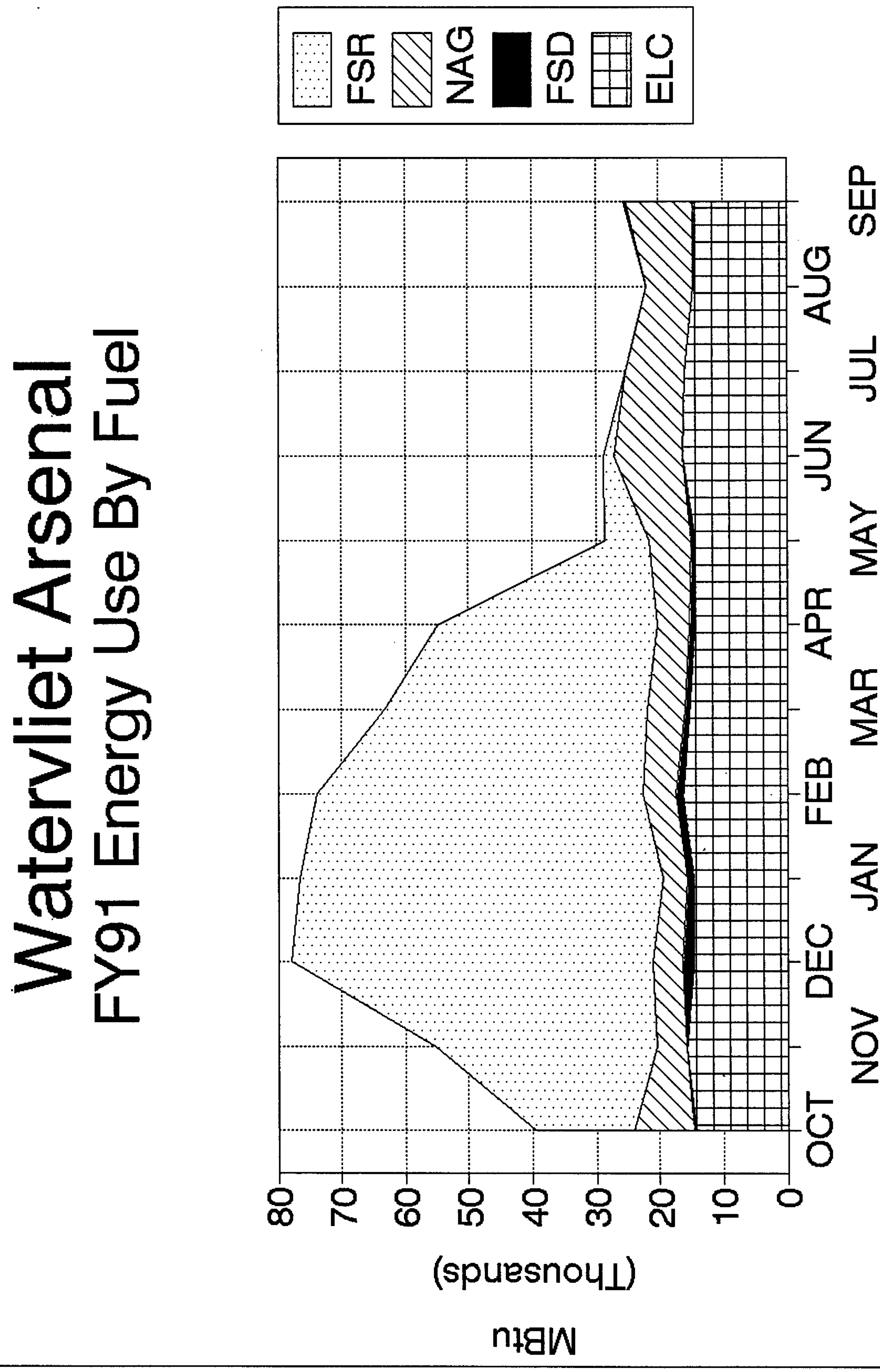
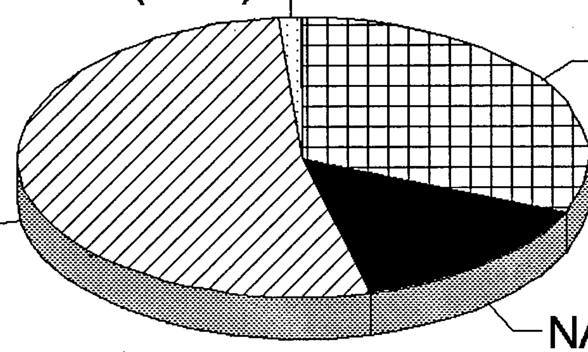

Watervliet Arsenal
FY91 Energy Use By Fuel
MBtu
(Thousands)
80
70
60
50
40
30
20
10
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FSR
NAG
FSD
ELC

Figure 2-9

Watervliet Arsenal
FY91 Facility Energy Use



Total Use = 571,000 MBtu

Figure 2-10

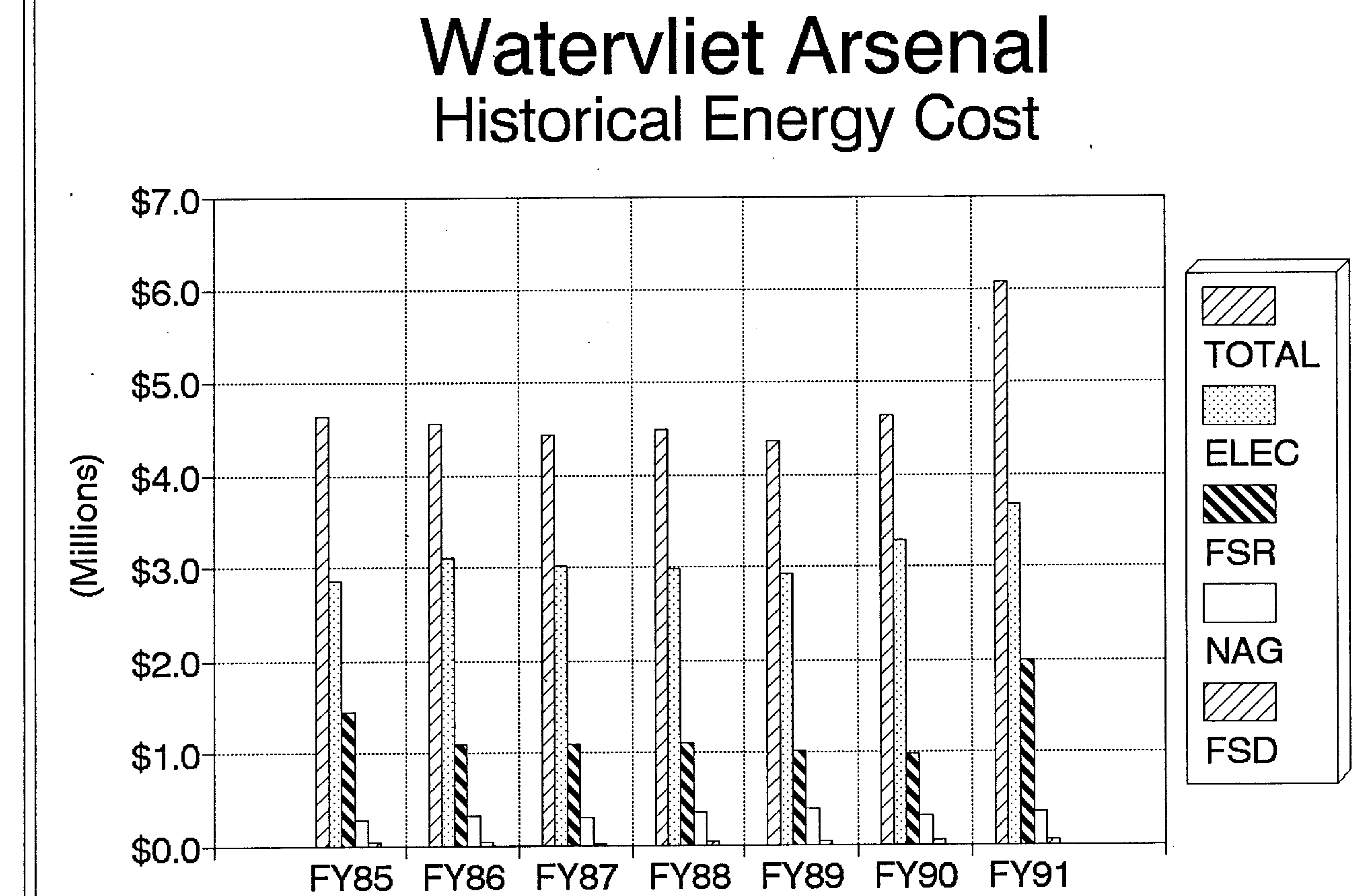

Watervliet Arsenal
Historical Energy Cost
$7.0
$6.0
$5.0
$4.0
$3.0
$2.0
$1.0
$0.0
(Millions)
FY85
FY86
FY87
FY88
FY89
FY90
FY91
TOTAL
ELEC
FSR
NAG
FSD

Figure 2-11

Watervliet Arsenal
Historical Energy Unit Cost

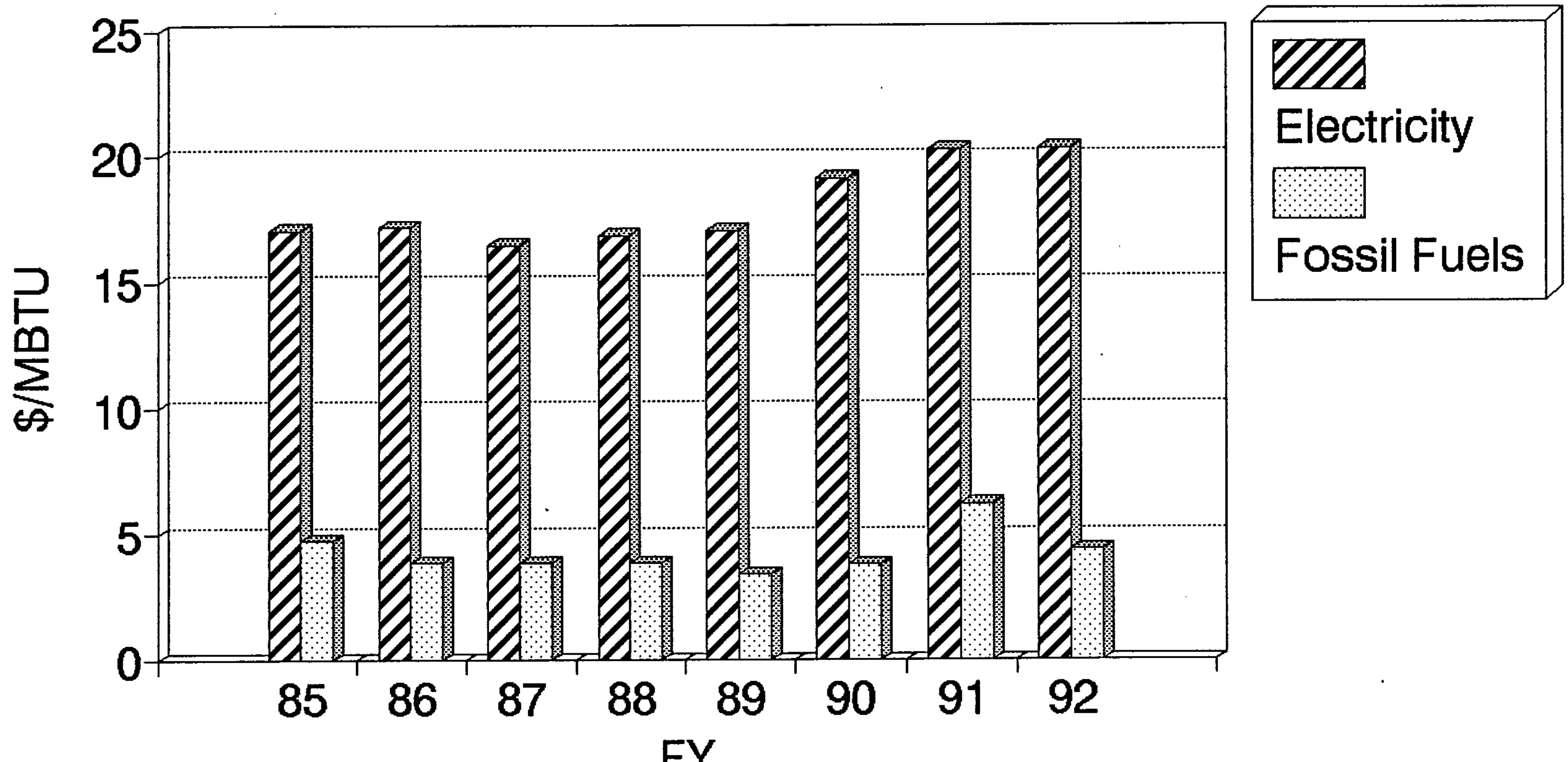


Figure 2-12

Monthly energy costs at WVA are shown in Figure 2-13. As in the case of consumption, boiler fuel costs vary widely, depending on weather. Electricity costs are a significant portion of the monthly costs, and can range from 55 percent of the monthly total to 90+ percent.

Electricity costs dominate the total annual energy bill because of the higher unit price. In FY 91, even with the unusually high fuel oil prices, electricity costs represented over 60 percent of the total expense of $6,024,000 (Figure 2-14).

2.4 Review of Energy Documents

The following documents were reviewed and results incorporated where appropriate.

- Process Energy Inventory at Watervliet Arsenal, CERL, 8/84
- Energy Engineering Analysis Program, PRC, 11/84
- Management Study for Process Energy, RS&H, 1/87
- Energy Monitoring and Control System, Vanderweil, 6/87
- Energy Management Proposal, Niagara Mohawk Power Corp., 10/90

Watervliet personnel reviewed the EEAP for industrial process projects to be updated in this report, but none were found.

Process Energy Inventory at Watervliet Arsenal, CERL, 8/84

This report documents the results of an in-depth metering program to determine the energy required to produce the 155M185 gun tube. The results are shown below.

Process	Energy Requirement (MBtu/tube)	Percent of Total
Forging	11.2	29.9
Heat Treatment	17.6	46.9
Machining	7.7	20.5
Chrome Plating	1.0	2.7
Total	37.5	100.0

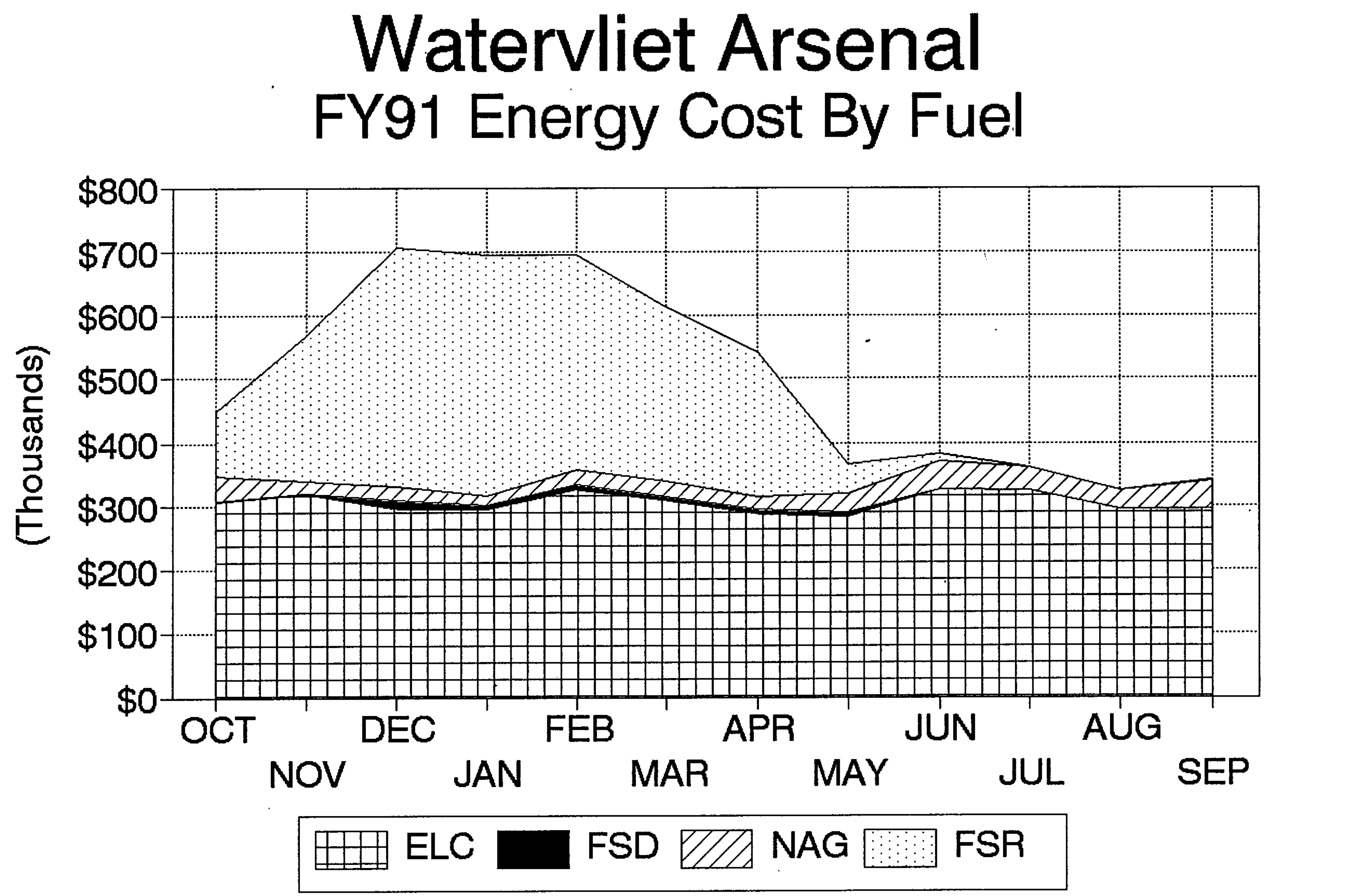
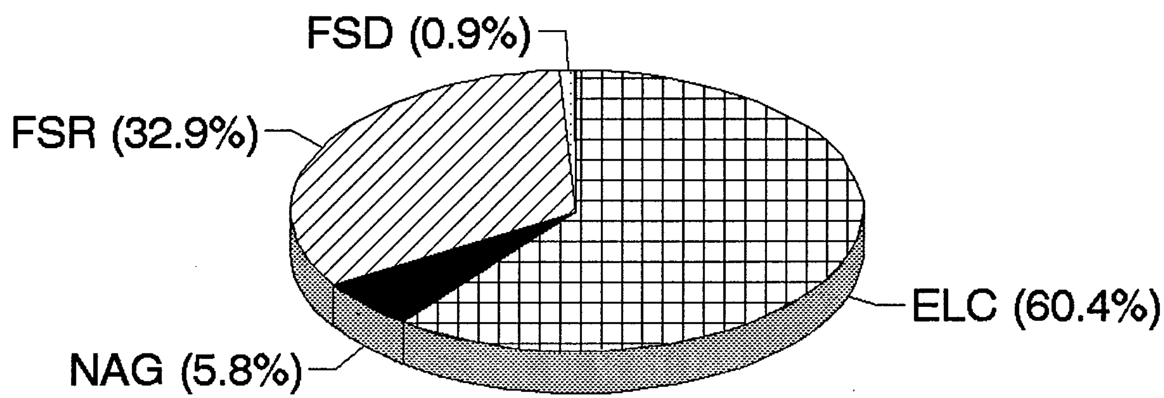

Watervliet Arsenal
FY91 Energy Cost By Fuel
(Thousands)
$800
$700
$600
$500
$400
$300
$200
$100
$0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
ELC
FSD
NAG
FSR

Figure 2-13

Watervliet Arsenal
FY91 Facility Energy Cost



Total Cost = $ 6,024,000

Figure 2-14

The report also recommended several energy conservation opportunities.

- o Increase Cheston Furnace efficiency
- o Reduce rotary forge idling and warm-up times
- o Reduce machine tool idling times
- o Recover heat from forged gun tubes

Energy Engineering Analysis Program, PRC, 11/84

Fossil fuel prices have decreased about 50 percent since 1984, but electricity has increased about the same since then.

	$/MBtu		
	FY 84	FY90	Percent Change
Fuel Oil No. 2	10.65	4.75	(55.4)
Fuel Oil No. 6	8.13	4.04	(50.3)
Electric	12.80	19.10	49.2
Natural Gas	--	3.54	--

Total utility costs were $6,126,850 in FY84 and $4,686,000 in FY90. Total energy consumption has decreased from 612,000 MBtu to 500,000 MBtu. These represent decreases of 24 percent and 18 percent, respectively.

The following reports were developed:

Volume I	Executive Summary
Volume II	Main Report--Increments A and B
Volume III	Increment C--Solar
	Increment C--Biomass
	Increment D--Cogeneration
	Increment E--Central Boiler Plant

Increments A, B and G

A comprehensive, installationwide energy audit was performed. A summary of the resulting projects are listed below:

Project	Cost (10/84)	Payback (yrs.)
Architectural/Structural/ Destratification Mods	$5,310,000	9.1
HVAC System Mods.	$345,000	6.2
EMCS	$735,000	2.1
Electrical Distribution System Mods	$304,000	7.9
Weatherization	$1,728,000	14.9
HVAC Modification	$123,000	14.8
Weatherization for Family Housing	$42,000	4.0

The Architectural/Structural Destratification Mods project included wall, ceiling, floor and steam pipe insulation; various window treatments and destratification fans.

HVAC System Mods were exhaust air heat recovery and reduction of outside air.

EMCS is self explanatory.

Electrical distribution modifications included wall insulation, HPS lighting, and window treatments.

HVAC modifications involved retrofitting existing roto cyclone dust collector in Building 125.

Increment C--Solar

Three solar applications were evaluated--DHW, space heating and combined DHW and space heating installation. The applications were studied for use at a four-building complex at the Rotterdam family housing area. The following is a summary of the results. None were recommended.

	Cost	SIR
DHW	$104,443	0.36
Space Heating	534,875	0.28
Combination	344,595	0.36

Increment C--Biomass

Wood was found to be the only economical, renewable energy resource available to Watervliet Arsenal. Life cycle cost analyses were performed comparing new oil-fired heating plant with a new fluidized-bed, wood-fired plant. The wood-fired plant cost was $8,194,782; the oil-fired, $3,198,386. However, due to the lower cost of wood, $4.34 (compared to $8.20/MBtu for No. 6 fuel oil) the wood-fired system had lower life-cycle costs.

Increment D--Cogeneration

PRC evaluated 567 to 759 kW coal-fired rankine-cycle systems with steam turbines. The total system cost was estimated at $865,000 to $944,774 additional costs to be added to the already recommended coal-fired boiler (Increment E). Cogeneration was not recommended.

Increment E--Central Boiler Plant

An evaluation was made as to the feasibility of converting the existing oil-fired boiler plant to a coal-fired plant. A life cycle cost analysis was performed comparing three boiler plant alternatives: oil-fired, spreader-stoker, coal-fired, and fluidized-bed, coal-fired. The results are shown below.

Alternative	Life Cycle Cost
Oil-Fired	$37,432,022
Spread-Stoker, Coal	$31,060,480
Fluidized-Bed, Coal	$28,799,044

Management Study For Process Energy, Reynolds, Smith and Hills, Inc., 1/87

The purpose of the study was to identify the energy intensive buildings at Watervliet Arsenal (WVA) and candidates for productivity indicators (primary production units). Recommendations were also made to determine what metering would be required to quantify energy use by productivity indicator. Each building was classified into one of the five categories described in the statement of work and listed below:

A. Facilities that are inactive or clearly not energy intensive. Energy consumption in these buildings will be managed using Btu/sf reduction goals. These facilities include, but are not limited to, family and troop housing, administrative buildings, schools, etc.;

B. Facilities which are not identifiable as clearly as those in "A" above, but upon physical visitation prove not to be energy intensive and will be recommended for management using Btu/sf reduction goals;

C. Facilities which are clearly energy intensive, but do not meet the definition of "Process Energy;"

D. Facilities which are energy intensive, but contain more than one process; and

E. Facilities which are energy intensive and contain a single measurable process.

The results of this analysis are shown in Tables II-1, II-2 and II-3.

Table II-1. WVA Building Classifications

Building Type	Area (sf)	Percentage
A	826,134	39
B	69,789	3
C	61,278	3
D	1,185,702	55
E	8,262	--
TOTALS	2,151,165	100

Table II-2. Energy Intensive Buildings at WVA (Classifications "C", "D", and "E")

Building No.	Description	Area (sf)	Category
20	Major Comp. Building	107,157	D
25	Minor Comp. Bldg. & OP Offices	185,886	D
35	Med. Caliber Tube Building	372,921	D
44	Dalliba Hall/Product Assurance	61,278	C
110	Heavy Caliber Tube Shop	208,574	D
123	Degreasing and Cleaning Bldg.	8,262	E
125	Breech Comp. & Weld Shop Bldg.	119,200	D
135	Heavy Caliber Tube Building	8,262	D
	Totals	1,255,242	

Table II-3. Energy Intensive Building at WVA--Additional Information

Building No.	Measurable Process	Energy Types** EL	NG	CA	STM	FO	Productivity Intensity Factor Candidates
20	Manufacture breech mechanisms	+		+	+		# of breech mech. for each type*, stnd. hrs
25	Manufacture breech mechanisms	+		+	+		# of breech mech., stnd. hrs
35	Manufacture gun barrels and breech	+	+	+	+		# of barrels for each type*, stnd. hrs
44	Dalliba Hall/ Product Assurance	+		+	+		None
110	Manufacture, diesel and pack gun barrels	+		+	+		# of gun barrels of each type*, stnd. hrs.
125	Manufacture breech mechanisms	+		+	+		# of barrels mech. of each type*, stnd. hrs
135	Manufacture gun barrels	+	+	+	+		# of gun barrels of each type*, stnd. hrs
123	Degreasing & Cleaning Bldg.	+		+	+		Lbs. of parts painted, gals. of paint

*105mm, 120mm, 155mm types

**EL--electricity
NG--natural gas
CA--compressed air
STM--steam
FO--fuel oil

Energy Management Proposal, Niagara-Mohawk Power Corporation, 10/90

An abbreviated energy audit was accomplished by A&C Enercom for Niagara-Mohawk. Five projects were recommended and are listed below:

Project	Cost	Payback (yrs.)
o Boiler O_2 Trim Controls	$25,000	2.0
o Energy Efficient Fluorescent Lamps	$32,905*	0.7
o Electronic Ballasts	$89,534*	3.3
o Cooling Tower Variable Speed Drive Conversion	$22,000	0.9
o Boiler F.D. Fan Variable Speed Drive Conversion	$13,000	0.8

*Qualifies for NMPC electric rebate programs.

Because this report was accomplished within the past year, the above projects were evaluated in more detail in this report (see Section 4).

Energy Management System Study, Vanderweil, 6/87

Vanderweil recommended an EMCS with microcomputers, located in various buildings to accomplish the following:

1. Monitor 86 electrical meters
2. Monitor 11 steam flow meters
3. Monitor and control 79 steam control valves
4. Monitor 149 space temperatures
5. Monitor and control major air conditioning equipment
6. Monitor and control compressors for shop air
7. Monitor and control large process ventilation units in Building 25
8. Monitor boilers at Rotherdam family housing area

Total system points are 331. The EMCS cost is $450,000 and saves $80,000 in energy costs each year. The simple payback is 5.6 years.

3.0 METHODOLOGY

3.1 Site Survey

Watervliet Arsenal (WVA) is a heavy manufacturing facility with over 80 buildings. The intent of this effort is to survey those buildings that contain the more energy-intensive processes. The scope of work for this study is limited to industrial process energy systems in the following buildings:

35	Medium Caliber Tube
110 (South end)	Heavy Caliber Tube
125	Breech Components and Welding Shop
135	Heavy Caliber Tube

Buildings 20, Major Components Machinery, 25, Minor Components Machinery, and 136, the Main Boiler Plant, were also surveyed for potential general energy conservation options (ECOs) applicability and to collect data involving several specific ECOs.

The emphasis for this study is to concentrate on energy savings in the industrial processes. A previous EEAP was performed that identified projects in the building envelope, space heating systems, etc. This type of information was not gathered here unless the building is conditioned because of specific process requirements. The site survey was conducted June 17 to June 24, 1991. Survey sheets for each of the buildings visited plus personnel interview forms are contained in Volume III.

3.2 Energy Analysis

3.2.1 ECOs. Energy savings for ECOs were calculated using standard methods documented in a variety of engineering texts including the ASHRAE Handbooks. Cost estimates were developed using 1991 Means Cost Data or through equipment vendors' quotes. The reference year for all cost estimates are June 1991. Because of unusually high oil costs in FY 91, all projects were updated using FY 92 prices as announced in October 1991.

3.2.2 <u>Economics</u>. Economic evaluations were performed using Version 1.0, Level 62 of the Life Cycle Cost in Design (LCCID) computer program available from the BLAST Support Office, Department of Mechanical and Industrial Engineering, University of Illinois at Urbana-Champaign. LCCID calculates life cycle costs, simple payback and SIR for use in evaluating energy conservation opportunities in DOD construction.

4.0 ENERGY ANALYSIS

4.1 Energy Conservation Opportunity (ECO) Evaluations

Each of the ECOs listed in the Scope of Work plus others were reviewed for their applicability and potential for significant energy savings and cost effectiveness for buildings representative of high energy consumption process areas at WVA. The results of this assessment are contained in tables in Appendix B.

For each of the ECOs that were chosen to be evaluated, energy savings were calculated, cost estimates made and Life Cycle Cost Analyses performed. A summary of the results are contained in Tables 4-1 and 4-2. The evaluated ECOs are described and listed in Table 4-1. An alphabetical listing of evaluated ECOs along with a summary of the energy and cost savings analysis is shown in Table 4-2. Table 4-3 contains a listing prioritized by SIR. Table 4-4 contains a list prioritized by simple payback. Backup data and calculations are contained in Appendix B.

Table 4-1. ECOs Evaluated--Titles

ECO #	Description
1	Power factor improvement
2	Natural gas fuel switch at the main boiler plant
3	Cogeneration
4	Dip tank covers with exhaust fan motor variable-speed drives
5	Electrical demand peak reduction
6	Plating area condensate return system
7	Condenser fan variable speed drives
8	High-efficiency fluorescent lighting and ballasts
9	Not used
10	High-efficiency electric motors
11	Boiler O_2 trim controls
12	Natural gas boilers
13	Reduce HVAC system air flow
14	High-efficiency chiller
15	EMCS
16	Return air system
17	Double pane windows
18	Storm windows
19	Occupancy sensors

Table 4-2. ECO Evaluations - Results

No.	ECO #	Project Name	Construction Cost Plus SIOH	Savings (Increase), MBtu/Year Elec	Dist	Resid	N Gas	Net Annual Cost Savings	SIR	Simple Payback (yrs)
1	1	Power Factor Improvement	$138,786	0	0	0	0	$31,000	3.1	4.7
2	2	Natural Gas Fuel Switch	$364,051	0	0	278,000	(278,000)	$66,700	4.4	5.8
3	3	Cogeneration	$1,303,232	0	0	28,400	(77,700)	$140,500	1.0	9.8
4	4	Dip Tank Covers & VSDs	$202,576	2,707	0	21,650	0	$141,900	11.6	1.5
5	5	Elec. Demand Peak Reduction	$0	0	0	0	0	$151,000	∞	0
6	6	Condensate Return	$16,712	0	0	2,255	3,205	$23,300	24.1	0.8
7	7	Condenser Fan VSDs	--	--	--	--	--	--	--	--
8	8A	34 W FL-Prod	$2,065	51	0	0	0	$970	6.8	2.2
9	8B	34 W FL&EB-Prod	$12,299	102	0	0	0	$2,000	2.6	6.1
10	8C	T8 FL&EB-Prod	$10,490	117	0	0	0	$2,400	3.3	4.7
11	8D	34W FL-NonProd	$52,591	589	0	0	0	$11,300	3.1	4.9
12	8E	34W FL&EB-NonProd	$316,753	1,104	0	0	0	$24,900	1.3	13.4
13	8F	T8 FL&EB-NonProd	$361,167	1,399	0	0	0	$30,600	1.3	12.5
14	8G	60W FL-Prod	$64,691	768	0	0	0	$13,200	3.0	5.2
15	8H	60W FL-Prod	$367,198	4,478	0	0	0	$91,200	3.6	4.3
16	8I	60W FL-NonProd	$108,685	58	0	0	0	$15,500	1.4	11.2
17	8J	60W FL&EB-NonProd	$60,651	339	0	0	0	$7,100	1.7	9.0
18	9	Not Used	--	--	0	0	0	--	--	--
19	10	High-Efficiency Motors	$111,227	1,602	0	0	0	$32,600	4.2	3.6
20	11	Boiler O2 Trim Controls	--	--	--		--	--	--	--
21	12	Natural Gas Boilers	$47,268	2,497	0	0	(3,122)	$37,800	10.7	1.3
22	13	Air Flow Reduction	$969	31	0	25	0	$740	11.4	1.4
23	14	High-Efficiency Chiller	$141,184	363	0	0	0	$7,400	0.8	20.2
24	15	EMCS	$522,900	0	0	9,851	0	$49,600	1.1	11.2
25	16	Return Air System	$66,495	0	0	3,985	0	$17,500	4.6	4.0
26	17	Double-Pane Wind. (1)	$495	0.02	0	2.55	0	$12	0.4	45.9
27	18	Storm Windows (1)	$107	0.02	0	2.55	0	$11	1.8	10.5
28	19	Occupancy Sensors	$11,976	211	0	0	0	$4,600	5.5	2.8

Note : VSD = Variable speed drive
FL = Fluorescents
EB = Electronic ballasts
Prod = Production areas
NonProd = Non-production areas
T8 = T8 fluorescents
(1) Per unit basis

Table 4-3. ECO Evaluations - Results Prioritized by SIR

No.	ECO #	Project Name	Construction Cost Plus SIOH	Savings (Increase), MBtu/Year Elec	Dist	Resid	N Gas	Net Annual Cost Savings	SIR	Simple Payback (yrs)
1	5	Elec. Demand Peak Reduction	$0	0	0	0	0	$151,000	∞	0
2	6	Condensate Return	$16,712	0	0	2,255	3,205	$23,300	24.1	0.8
3	4	Dip Tank Covers & VSDs	$202,576	2,707	0	21,650	0	$141,900	11.6	1.5
4	13	Air Flow Reduction	$969	31	0	25	0	$740	11.4	1.4
5	12	Natural Gas Boilers	$47,268	2,497	0	0	(3,122)	$37,800	10.7	1.3
6	8A	34 W FL-Prod	$2,065	51	0	0	0	$970	6.8	2.2
7	19	Occupancy Sensors	$11,976	211	0	0	0	$4,600	5.5	2.8
8	16	Return Air System	$66,495	0	0	3,985	0	$17,500	4.6	4.0
9	2	Natural Gas Fuel Switch	$364,051	0	0	278,000	(278,000)	$66,700	4.4	5.8
10	10	High-Efficiency Motors	$111,227	1,602	0	0	0	$32,600	4.2	3.6
11	8H	60W FL-Prod	$367,198	4,478	0	0	0	$91,200	3.6	4.3
12	8C	T8 FL&EB-Prod	$10,490	117	0	0	0	$2,400	3.3	4.7
13	8D	34W FL-NonProd	$52,591	589	0	0	0	$11,300	3.1	4.9
14	1	Power Factor Improvement	$138,786	0	0	0	0	$31,000	3.1	4.7
15	8G	60W FL-Prod	$64,691	768	0	0	0	$13,200	3.0	5.2
16	8B	34 W FL&EB-Prod	$12,299	102	0	0	0	$2,000	2.6	6.1
17	18	Storm Windows (1)	$107	0.02	0	2.55	0	$11	1.8	10.5
18	8J	60W FL&EB-NonProd	$60,651	339	0	0	0	$7,100	1.7	9.0
19	8I	60W FL-NonProd	$108,685	58	0	0	0	$15,500	1.4	11.2
20	8E	34W FL&EB-NonProd	$316,753	1,104	0	0	0	$24,900	1.3	13.4
21	8F	T8 FL&EB-NonProd	$361,167	1,399	0	0	0	$30,600	1.3	12.5
22	15	EMCS	$522,900	0	0	9,851	0	$49,600	1.1	11.2
23	3	Cogeneration	$1,303,232	0	0	28,400	(77,700)	$140,500	1.0	9.8
24	14	High-Efficiency Chiller	$141,184	363	0	0	0	$7,400	0.8	20.2
25	17	Double-Pane Wind. (1)	$495	0.02	0	2.55	0	$12	0.4	45.9
26	11	Boiler O2 Trim Controls	--	--	--	--	--	--	--	--
27	9	Not Used	--	--	0	0	0	--	--	--
28	7	Condenser Fan VSDs	--	--	--	--	--	--	--	--

Note : VSD = Variable speed drive
FL = Fluorescents
EB = Electronic ballasts
Prod = Production areas
NonProd = Non-production areas
T8 = T8 fluorescents
(1) Per unit basis

Table 4-4. ECO Evaluations - Results Prioritized by Simple Payback

No.	ECO #	Project Name	Construction Cost Plus SIOH	Savings (Increase), MBtu/Year Elec	Dist	Resid	N Gas	Net Annual Cost Savings	SIR	Simple Payback (yrs)
1	5	Elec. Demand Peak Reduction	$0	0	0	0	0	$151,000	∞	0.0
2	6	Condensate Return	$16,712	0	0	2,255	3,205	$23,300	24.1	0.8
3	12	Natural Gas Boilers	$47,268	2,497	0	0	(3,122)	$37,800	10.7	1.3
4	13	Air Flow Reduction	$969	31	0	25	0	$740	11.4	1.4
5	4	Dip Tank Covers & VSDs	$202,576	2,707	0	21,650	0	$141,900	11.6	1.5
6	8A	34 W FL-Prod	$2,065	51	0	0	0	$970	6.8	2.2
7	19	Occupancy Sensors	$11,976	211	0	0	0	$4,600	5.5	2.8
8	10	High-Efficiency Motors	$111,227	1,602	0	0	0	$32,600	4.2	3.6
9	16	Return Air System	$66,495	0	0	3,985	0	$17,500	4.6	4.0
10	8H	60W FL-Prod	$367,198	4,478	0	0	0	$91,200	3.6	4.3
11	1	Power Factor Improvement	$138,786	0	0	0	0	$31,000	3.1	4.7
12	8C	T8 FL&EB-Prod	$10,490	117	0	0	0	$2,400	3.3	4.7
13	8D	34W FL-NonProd	$52,591	589	0	0	0	$11,300	3.1	4.9
14	8G	60W FL-Prod	$64,691	768	0	0	0	$13,200	3.0	5.2
15	2	Natural Gas Fuel Switch	$364,051	0	0	278,000	(278,000)	$66,700	4.4	5.8
16	8B	34 W FL&EB-Prod	$12,299	102	0	0	0	$2,000	2.6	6.1
17	8J	60W FL&EB-NonProd	$60,651	339	0	0	0	$7,100	1.7	9.0
18	3	Cogeneration	$1,303,232	0	0	28,400	(77,700)	$140,500	1.0	9.8
19	18	Storm Windows (1)	$107	0.02	0	2.55	0	$11	1.8	10.5
20	8I	60W FL-NonProd	$108,685	58	0	0	0	$15,500	1.4	11.2
21	15	EMCS	$522,900	0	0	9,851	0	$49,600	1.1	11.2
22	8F	T8 FL&EB-NonProd	$361,167	1,399	0	0	0	$30,600	1.3	12.5
23	8E	34W FL&EB-NonProd	$316,753	1,104	0	0	0	$24,900	1.3	13.4
24	14	High-Efficiency Chiller	$141,184	363	0	0	0	$7,400	0.8	20.2
25	17	Double-Pane Wind. (1)	$495	0.02	0	2.55	0	$12	0.4	45.9
26	11	Boiler O2 Trim Controls	--	--	--	--	--	--	--	--
27	9	Not Used	--	--	0	0	0	--	--	--
28	7	Condenser Fan VSDs	--	--	--	--	--	--	--	--

Note : VSD = Variable speed drive
FL = Fluorescents
EB = Electronic ballasts
Prod = Production areas
NonProd = Non-production areas
T8 = T8 fluorescents
(1) Per unit basis

ECO Number 1

POWER FACTOR IMPROVEMENT

Discussion

The electric bill that WVA pays each month is based on the total electricity consumed, the on-peak electric demand, and the lagging reactive electric demand. Approximately 1.5 percent of WVA's monthly electric utility cost is attributed to lagging reactive demand charges. Lagging reactive demand is measured in kilovolt-amperes (KVAR) and is caused by the use of electrical equipment that requires reactive (magnetizing) current for inductive loads. Examples of this equipment at WVA include induction motors (particularly when operated at less than full load), generators, transformers, induction furnaces and fluorescent lamp ballasts.

The Niagara Mohawk Power Corporation currently charges about $0.86 per billed KVAR of reactive electric demand. This charge only applies to the KVAR that reduces the power factor below 94.9 percent. The power factor at WVA currently averages about 78 percent. Combining the 78-percent power factor with an average electric demand of 10,900 KW results in a billed reactive demand of about 5,120 KVAR each month. The cost associated with this billed reactive demand is approximately $4,400 per month or $52,800 per year.

A daily profile of WVA's electric power and reactive power demand for June 14, 1990 is shown in Figure 4-1-1. An inductive load has been energized (or de-energized) when the KW and KVAR trends are both increasing (or decreasing) at about the same rate. When the KW demand increases but the KVAR demand does not, this means a non-inductive load (an electric furnace for example) has been energized. Figure 4-1-2 shows the power factor profile for WVA on the same day. When lights and other non-inductive loads are brought on line in the morning, the power factor increases to its highest value of the day. As the inductive loads are turned on throughout the day, the power factor trends downward.

Improving the power factor to 94.9 percent at WVA would save $52,800 per year in electric utility costs. In addition to lowering utility costs, improving the facility power factor has several other benefits. First, it raises the

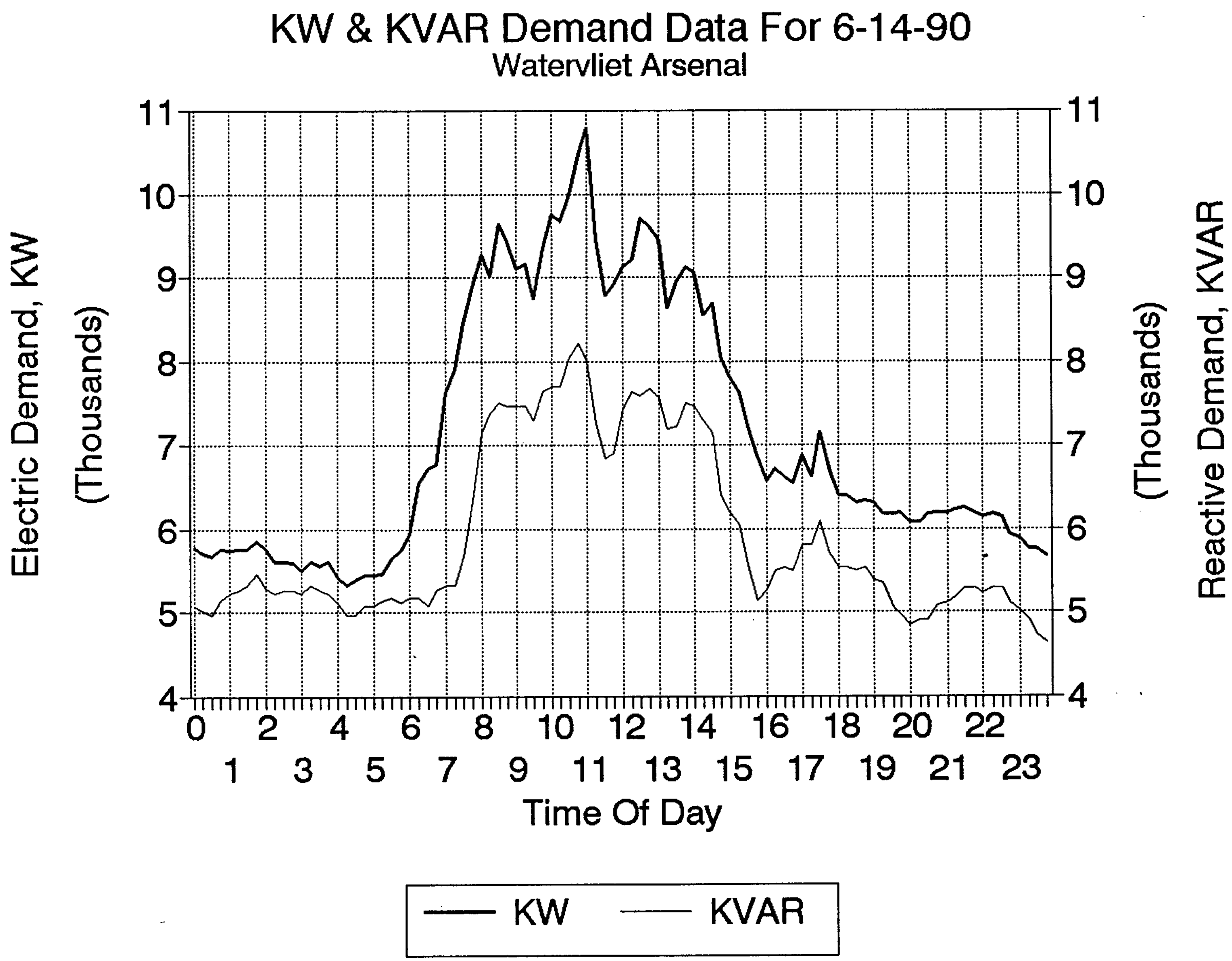

KW & KVAR Demand Data For 6-14-90
Watervliet Arsenal
Electric Demand, KW
(Thousands)
Reactive Demand, KVAR
(Thousands)
Time Of Day
KW
KVAR

Figure 4-1-1

Power Factor Profile For 6-14-90
Watervliet Arsenal

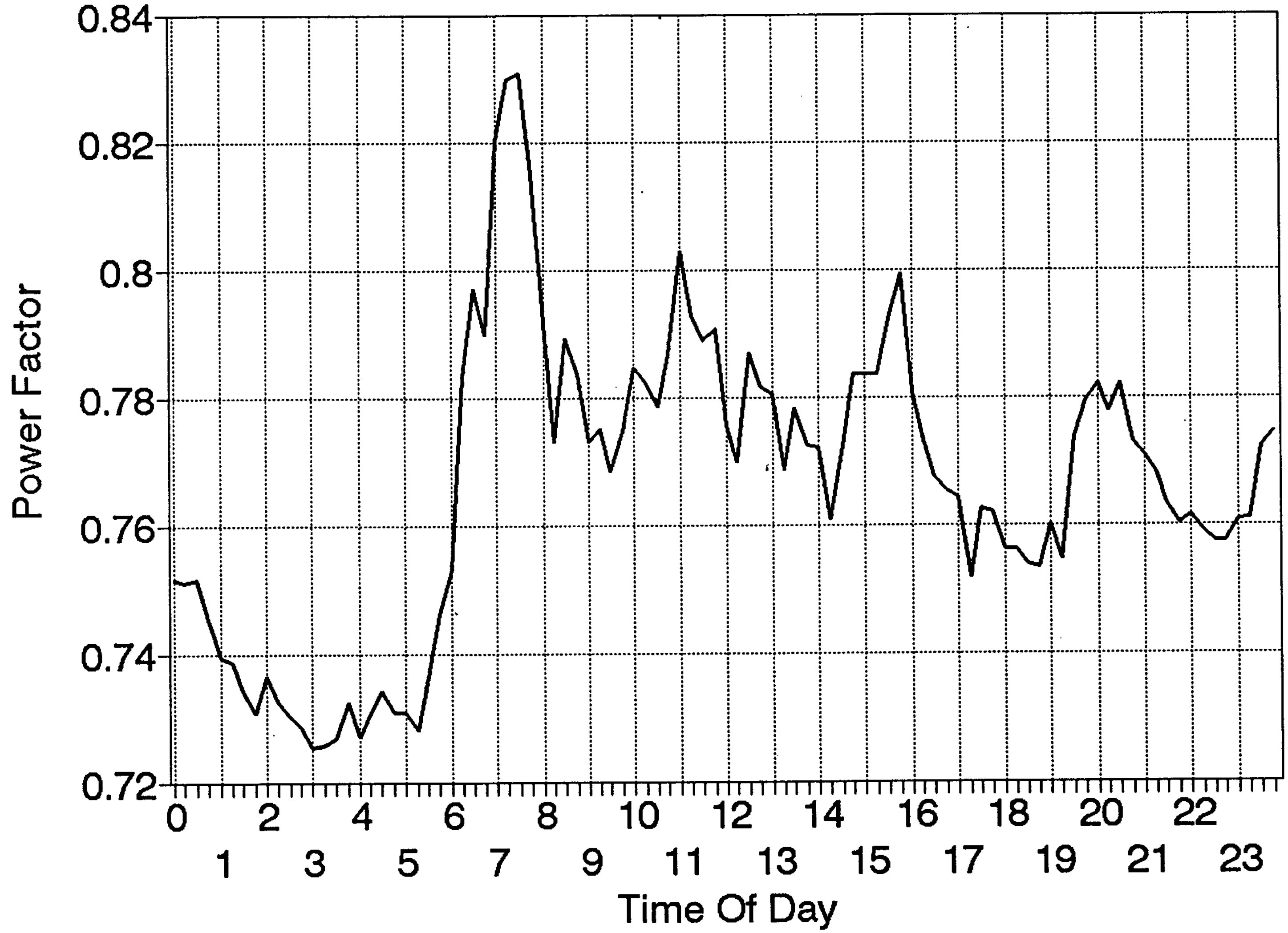


Figure 4-1-2

plant's electrical system capacity since the transformer loads can be increased. Improving the power factor also reduces electrical system losses and improves voltage regulation.

The overall power factor at WVA will not necessarily improve when process equipment is taken off line. For example, assume there are 20 lathes in a building and each one is operating at a power factor of about 0.75. Turning off two of the lathes will reduce the electricity consumption by ten percent but the overall power factor for the remaining lathes will still be approximately 0.75.

The lagging reactive demand (low power factor) can be improved by adding reactive KVAR to the circuit from another source. This can be most easily accomplished by installing capacitors. The capacitors provide a 180-degree phase difference from the inductive current requirement which eliminates the need for the power system to supply the reactive current. There are no energy savings achieved by installing capacitors. Motors will still draw the same amount of reactive current, but it will be supplied by the capacitors rather than the electrical system.

This analysis assumes that the capacitors will be installed ahead of each piece of equipment. Some smaller capacitors will be required which have a higher initial cost per KVAR. However, this type of arrangement eliminates the need for additional switching since the capacitors can be switched with the equipment. Another benefit of this arrangement is that it allows the capacitors to be moved with the equipment when the process line is modified.

Electric motors that most strongly influence the power factor are those with the largest horsepower, motors that operate at low speeds and motors that are run frequently (especially at low loads). In late 1985, six specific pieces of process equipment in Buildings 25, 35 and 135 were tested for motor loading (see Appendix for details). The results indicated an average motor loading of approximately 38 percent.

During the site survey, 36 pieces of process equipment in Building 135 were identified as potential candidates for power factor improvement. This

equipment includes the rotary forge, Cheston furnace, Selas furnace, four presses, 25 lathes and four hones. A list of the equipment along with the number and size of the motors for each piece is located in the appendix. Motors in Buildings 20 and 110 were identified from the "Internal and External Survey Report, Final Submission" by Galson & Galson. These reports were completed in 1985 and copies of the appropriate pages are located in the Appendix. This analysis assumes that the motors identified for power factor improvement are operating on a regular basis.

A preliminary analysis was completed to determine the cost effectiveness of installing capacitors on various sizes of motors. The results indicated that installing capacitors on motors of 15 horsepower and smaller causes a payback of more than ten years. Therefore, only motors that are 20 horsepower and greater are considered in this report.

Recommendation

Based on the benefits and the Life Cycle Cost Analysis, this project is recommended.

Construction Cost	$130,930
Annual Energy Savings (MBtu/year)	
Electricity	0
Natural Gas	0
Fuel Oil No. 2	0
Fuel Oil No. 6	0
Annual Energy Cost Savings ($/year)	$30,878
SIR	3.1
Simple Payback (years)	4.7

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO #1 POWER FACTOR IMPROVEMENT
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$	130930.
B. SIOH	$	7856.
C. DESIGN COST	$	7856.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	146642.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	0.	$ 0.	15.19	0.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	0.	$ 0.	18.56	0.
D. NAT G	$ 4.16	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		0.	$ 0.		$ 0.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 30878.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 453289.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 453289.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 0.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) .00
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 30878.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 453289.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 3.09
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 4.75

ECO Number 2

NATURAL GAS FUEL SWITCH

Discussion

The main boiler plant (Building 136) uses No. 6 fuel oil to provide steam for space heating and process loads throughout the Arsenal. Natural gas is utilized on the installation for the Selas furnace, the cafeteria and the Building 35 "donkey" boiler. This ECO proposes to install a new natural gas line for the main boiler plant.

The new natural gas line would enter the installation from the west near the main substation (see Figure 4-2-1). Niagara Mohawk Power Corporation (NMPC) who provides both electricity and natural gas to the Arsenal, proposed this routing in 1984. WVA has recently asked NMPC to re-evaluate this project and offer another proposal. This effort began in the summer of 1991 and is expected to be completed before 1993. The results of the NMPC evaluation will be incorporated in this report if available before the final report is completed.

There are other advantages to switching to natural gas. Natural gas is a cleaner burning fuel than fuel oil, and its operation and maintenance (including pre-heating) requirements are less. Also, switching to natural gas will give the Arsenal dual-fuel capability which will increase the plant reliability and sensitivity to fuel shortages.

Recommendations

WVA should carefully consider the NMPC offer. The economics are directly tied to present and future price of No. 6 fuel oil. In general, however, the dual-fuel capability gained by this ECO is recommended because of its long-term benefits--increased reliability, reduced operating and maintenance, cleaner emissions and fuel selection flexibility. Although WVA will be required to purchase a certain amount of natural gas if the NMPC proposal is accepted, WVA will be able to use natural gas or switch to No. 6 fuel oil when its price is lower.

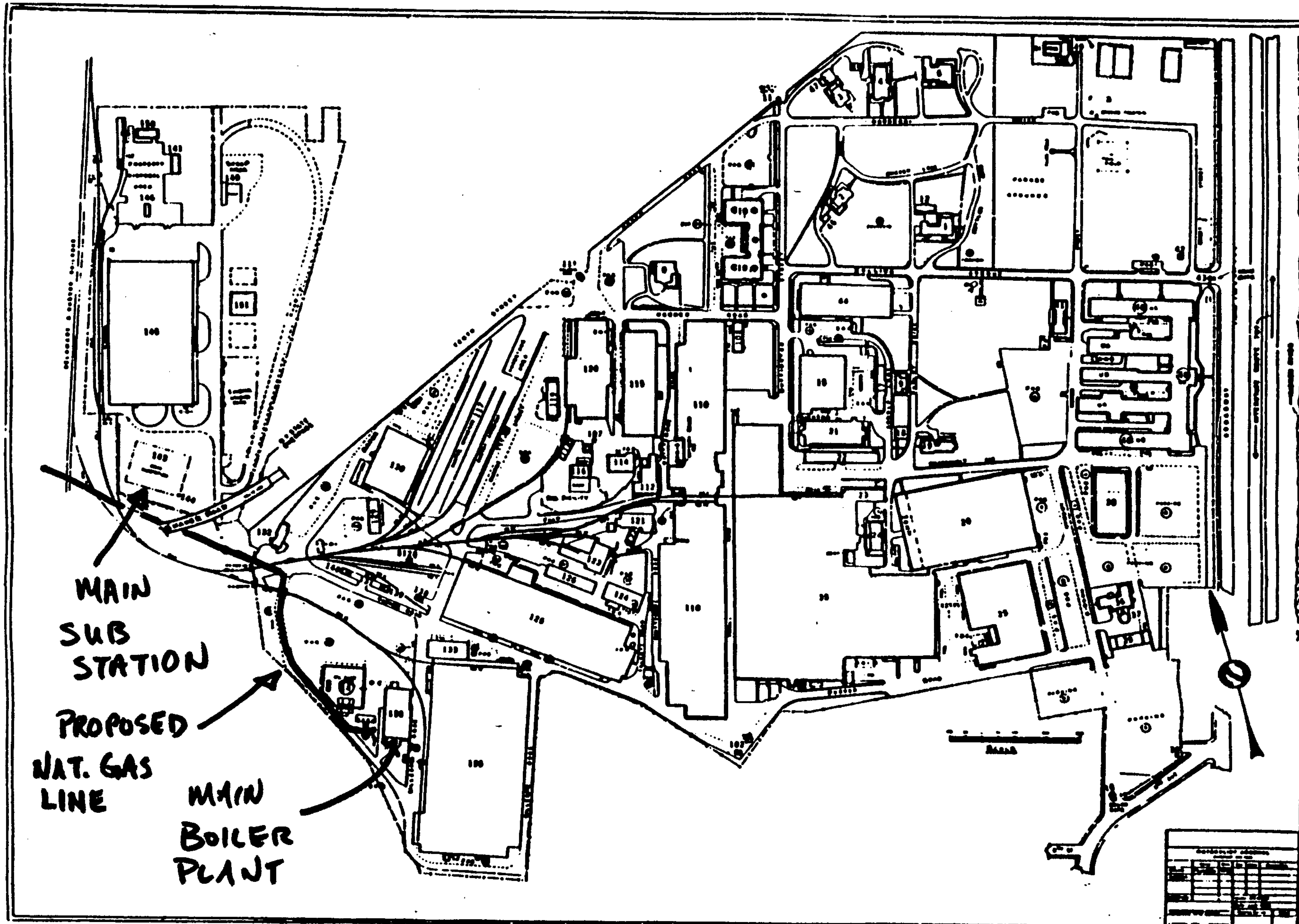


Figure 4-2-1
NMPC New Natural Gas Line Location

Construction Cost	$343,444
Annual Energy Savings (MBtu/year)	
Fuel Oil No. 6	278,000
Natural Gas	(278,000)
Annual Energy Cost Savings ($/year)	$66,720
SIR	4.4
Simple Payback (years)	5.8

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO #2 NATURAL GAS FUEL SWITCH
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: P. HUTCHINS

1. INVESTMENT

A. CONSTRUCTION COST	$	343444.
B. SIOH	$	20607.
C. DESIGN COST	$	20607.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	384658.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	0.	$ 0.	15.19	0.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	278000.	$ 1223200.	18.56	22702590.
D. NAT G	$ 4.16	*******	$-1156480.	18.16	-21001680.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		0.	$ 66720.		$ 1700916.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 561302.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 66720.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1700916.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 4.42
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 5.77

ECO Number 3

COGENERATION

Discussion

Watervliet Arsenal (WVA) spent $4,643,000 in energy costs for fiscal year 1990. Almost three-quarters of this amount was for electricity. The electricity rate, which averages 6.8¢/kwh, is considerably higher than most U.S. military installations. All of these factors plus a year-round demand for process steam, make WVA a candidate for cogeneration.

The fundamental prerequisite for an economical cogeneration system is continuous and concurrent requirements for electricity and thermal energy. Figure 4-3-1 shows a typical weekly electricity demand load for WVA. Essentially, WVA uses 3 MW of electricity, 365 days of the year, around the clock. During the work week, the demand hardly drops below 5 MW.

Average hourly steam use for non-space heating is shown in Figure 4-3-2. There is a constant 7,000 pounds per hour of 120 psig steam use during the work week with a reduction to virtually zero on the weekends. This consistent year-round steam requirement, plus a constant electricity load, make cogeneration a possibility.

In the State of New York, the installation's electricity demand is not as important due to the "buy all, sell all" regulations. Discussions with Niagara Mohawk Power Corporation, which services WVA, revealed that NMPC must purchase all of the cogenerated power that WVA produces at a current rate of 6¢/kwh.

The final requirement that is necessary for favorable cogeneration economics is a source of inexpensive fuel. In virtually all cases, this means natural gas. WVA is currently working with NMPC for the addition of a new natural gas service to the main boiler plant. It would be prudent for WVA to be certain any new service would have extra capacity for the possibility of adding cogeneration in the future. Calculations performed for this study show energy use for cogeneration would be about 16 MBtu/hr of natural gas for a 1130 kW gas turbine (see Appendix for details).

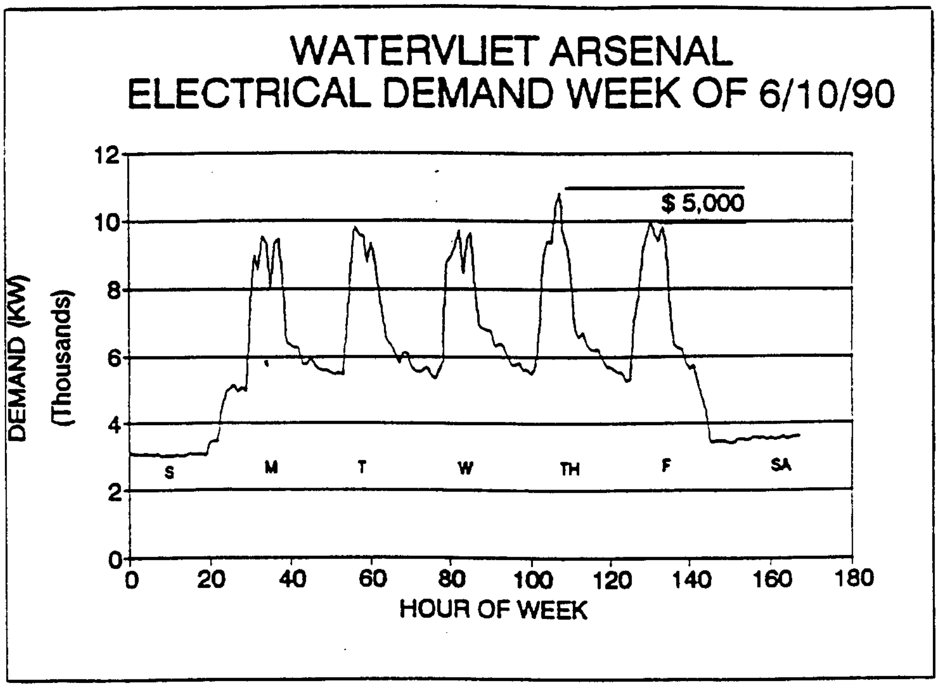


Figure 4-3-1

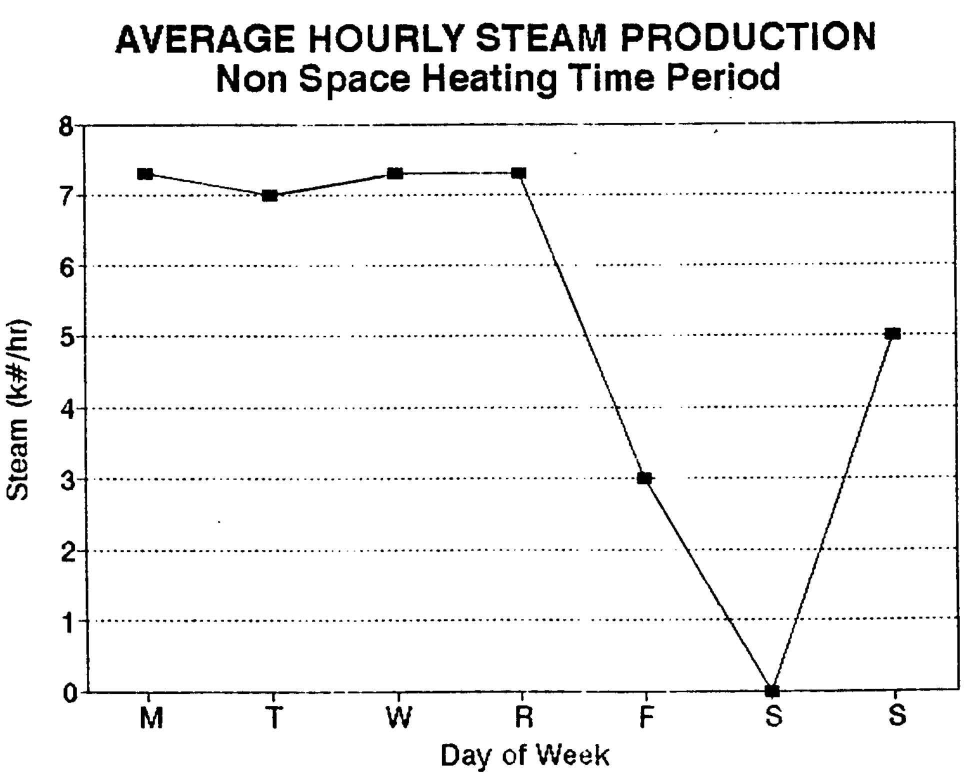


Figure 4-3-2

Two types of cogenerators were evaluated here--reciprocating engines and gas turbines. The evaluation showed that the gas turbine generating about 1130 kW is the more cost-effective of the two. The primary reason for this is the requirement for 120 psig steam.

Recommendations

Based on the results of the Life Cycle Cost Analysis, this ECO is recommended. A summary of the results are below.

Construction Cost	$1,229,464
Annual Energy Savings (MBtu/year)	
No. 6 Fuel Oil	28,400
Natural Gas	(77,700)
Annual Maintenance Costs ($/year)	$68,000
Annual Electricity Sales	$406,800
Annual Energy Cost Savings ($/year)	$140,528
SIR	1.0
Simple Payback (years)	9.8

Based on the Life Cycle Cost Analysis, cogeneration is a marginal project at Watervliet. The major impediment at this time is the requirement for a high-volume natural gas line.

If WVA desires to pursue cogeneration, third-party financing, ownership and operation is recommended.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO3
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO #3 COGENERATION
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: P. HUTCHINS

1. INVESTMENT

A. CONSTRUCTION COST	$ 1229464.
B. SIOH	$ 73768.
C. DESIGN COST	$ 73768.
D. SALVAGE VALUE COST	-$ 0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$ 1377000.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	0.	$ 0.	15.19	0.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	28400.	$ 124960.	18.56	2319258.
D. NAT G	$ 4.16	-77700.	$ -323232.	18.16	-5869893.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		-49300.	$ -198272.		$ -3550636.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 338800.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 4973584.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 4973584.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ -1171710.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) -3.43
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 140528.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1422949.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.03
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 9.80

ECO Number: 4

DIP TANK COVERS AND VARIABLE-SPEED DRIVES (VSDs)

Discussion

Noxious dip tank fumes are exhausted in accordance with OSHA guidelines to protect workers in the Small Parts Plating Area of Building 35. Ventilation of the fumes is accomplished by drawing room air across the surface of the dip tank fluid, into an exhaust duct, through a ventilation fan and out through the roof to the atmosphere. The warm room air used to entrain the fumes must be replaced with outside air that must be heated. The exhausted air represents a significant heat loss.

The amount of exhausted air can be minimized by covering the dip tank and draft slot with a flexible, chemically resistant cover whenever the tank is not in use. With the cover in place, the fume evolution potential is sharply reduced, so the amount of exhaust air can also be reduced. The reduction in exhaust air represents substantial energy savings from both reduced warm air loss as well as from reduced exhaust fan power.

This ECO provides all vented dip tanks with a flexible, chemically resistant cover (like a tarpaulin) permanently fixed to each tank/vent-duct assembly. The cover can be extended or retracted by appropriate means ranging from manually rolling and unrolling to spring-assisted retraction, similar to the operation of a window shade (see Volume II for sketches). This ECO also provides for exhaust fan speed reduction whenever the covers are in place. The speed reduction will be accomplished by measuring and controlling a set pressure rise across the exhaust fan with a differential pressure sensor and controller which in turn will adjust the speed of the exhaust fan motor through a variable frequency drive. This fan speed control will be particularly effective where fans serve multiple tanks. With this control technique, the OSHA-mandated exhaust air flows can be maintained under all conditions of variable building pressure and variable tank use.

This approach to dip tank operation has been discussed with OSHA in Harrisburg, Pennsylvania, and determined to be acceptable.

Recommendation

Based on the Life Cycle Cost Analysis and a discussion with OSHA, it is recommended that flexible, chemically resistant dip tank covers be installed along with vent fan pressure differential controllers on all vented dip tanks.

Additional maintenance would be required to replace the tank covers approximately every five years.

Construction Cost	$191,109
Annual Energy Savings (MBtu/yr)	
No 6 Fuel Oil	21,650
Electricity	2,707
Annual Energy Cost Savings ($/yr)	$150,300
Additional Annual Maintenance ($/yr)	$8,480
Net Annual Savings ($/yr)	$141,900
SIR	11.6
Simple Payback (years)	1.5

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO4
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO #4 DIP TANK COVERS & VSD
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: P. HUTCHINS

1. INVESTMENT

A. CONSTRUCTION COST	$	191109.
B. SIOH	$	11467.
C. DESIGN COST	$	11467.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	214043.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	2707.	$ 55087.	15.19	836778.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	21650.	$ 95260.	18.56	1768026.
D. NAT G	$ 4.16	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		24357.	$ 150347.		$ 2604804.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -8480.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -124486.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -124486.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 859585.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 141867.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2480317.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 11.59
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 1.51

ECO Number 5

ELECTRICAL DEMAND PEAK REDUCTION

Discussion

The electric bill that WVA pays each month is based on the total electricity consumed, the on-peak electric demand, and the lagging reactive electric demand. About 20 percent of WVA's monthly electric cost is due to on-peak electric demand charges. Electrical demand, measured in kilowatts (KW), is the average amount of energy consumed during a 15-minute period of time called a demand interval. On-peak demand charges are assessed on the maximum electrical demand for the monthly billing period.

The Niagara Mohawk Power Corporation currently charges WVA about $5.53 for each kilowatt of on-peak electrical demand. For the year beginning June 1990 through May 1991, WVA's on-peak electric demand averaged over 10,900 KW each month. The cost of this electrical demand averaged about $56,700 per month for a total annual cost of over $680,000.

Figure 4-5-1 depicts an average weekday at WVA. About three Mega Watts (MW) of power are required for non-process base loads such as lighting, ventilation and air conditioning. Another 2.5-MW is required by process base loads which includes lighting, some process heating and smaller electric-powered process equipment. The remaining five to 5.5 MW of WVA's electric demand is from large process equipment that is operated intermittently during the 7 a.m. to 3 p.m. shift.

Daily profiles of WVA's electrical demand for Wednesday June 13, and Thursday June 14, 1990 are shown in Figure 4-5-2 and Figure 4-5-3, respectively. The peak demand for Wednesday was approximately 9,700 KW and occurred between 10:15 am and 10:30 am. The peak demand for Thursday was approximately 10,800 KW and occurred between 11:00 am and 11:15 am. At the current rate of $5.53 per KW, the 1,100-KW increase between these two days of operation would cost WVA an additional $6,000 for that month. This analysis assumes that both of these days were relatively normal operating days. Therefore, the primary difference in the electrical demand was how many of the electrical intensive processes were operating at the same time.

Typical Electric Demand Profile
Watervliet Arsenal

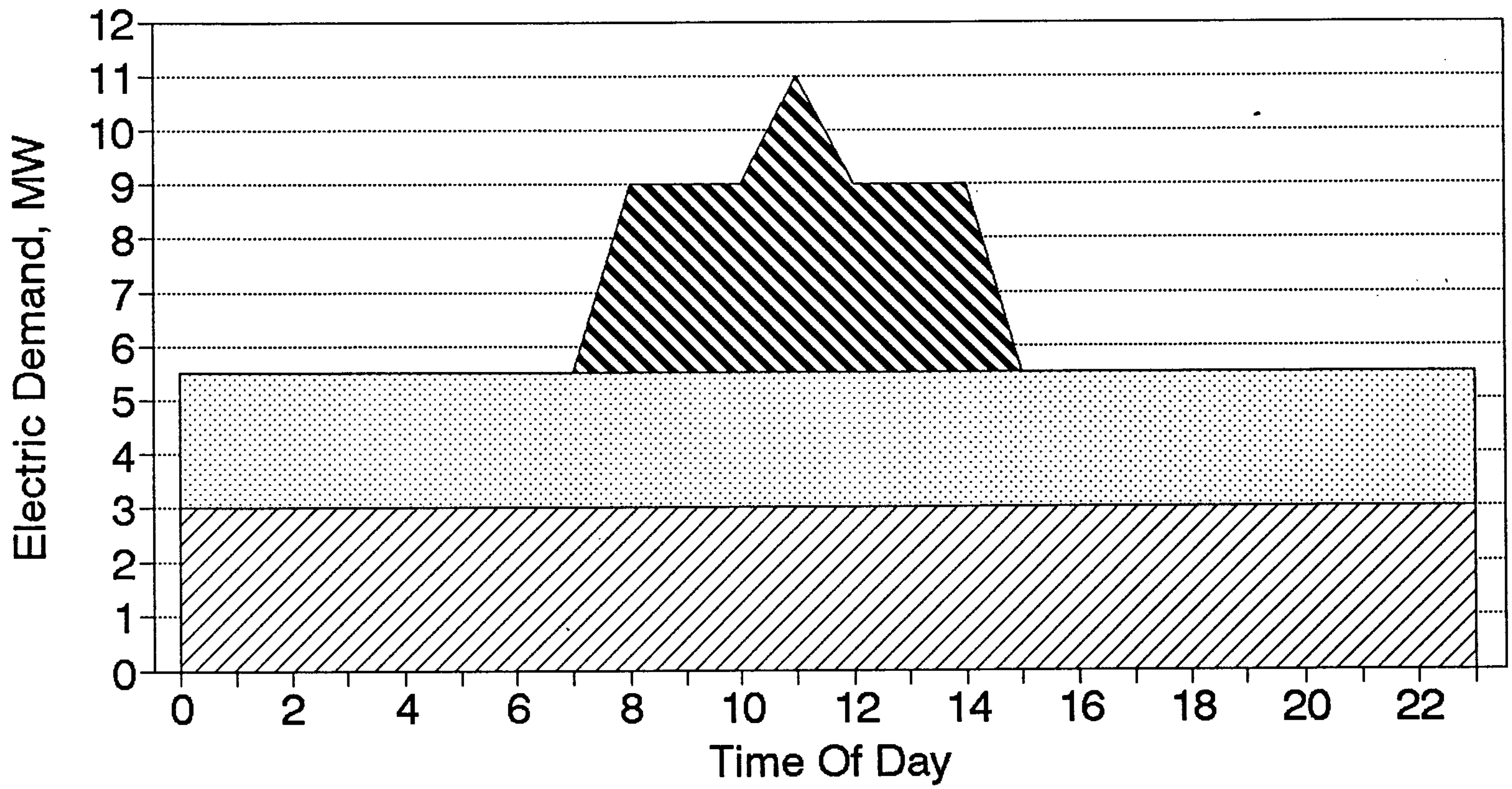


Figure 4-5-1

Electric Demand Profile For 6-13-90
Watervliet Arsenal

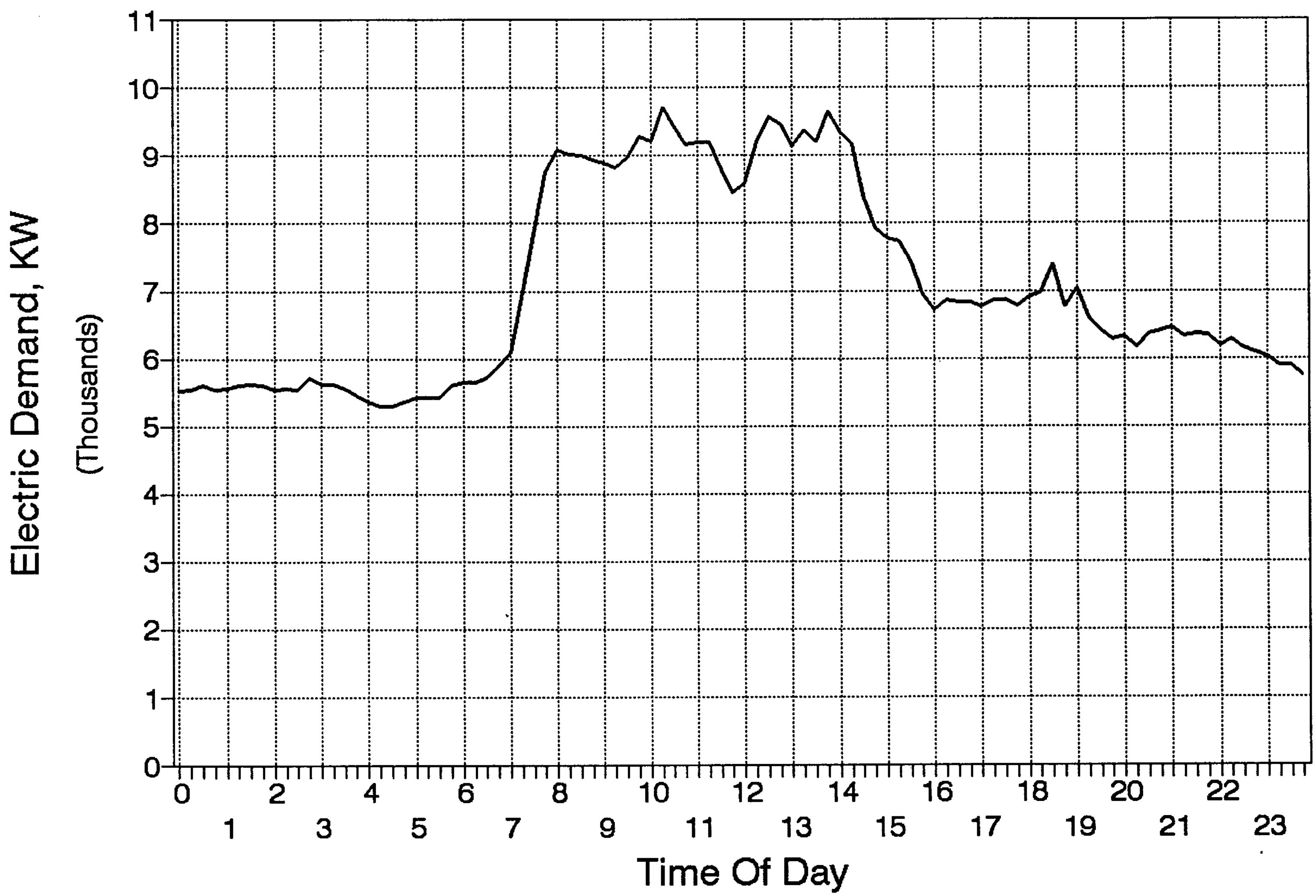


Figure 4-5-2

Electric Demand Profile For 6-14-90
Watervliet Arsenal

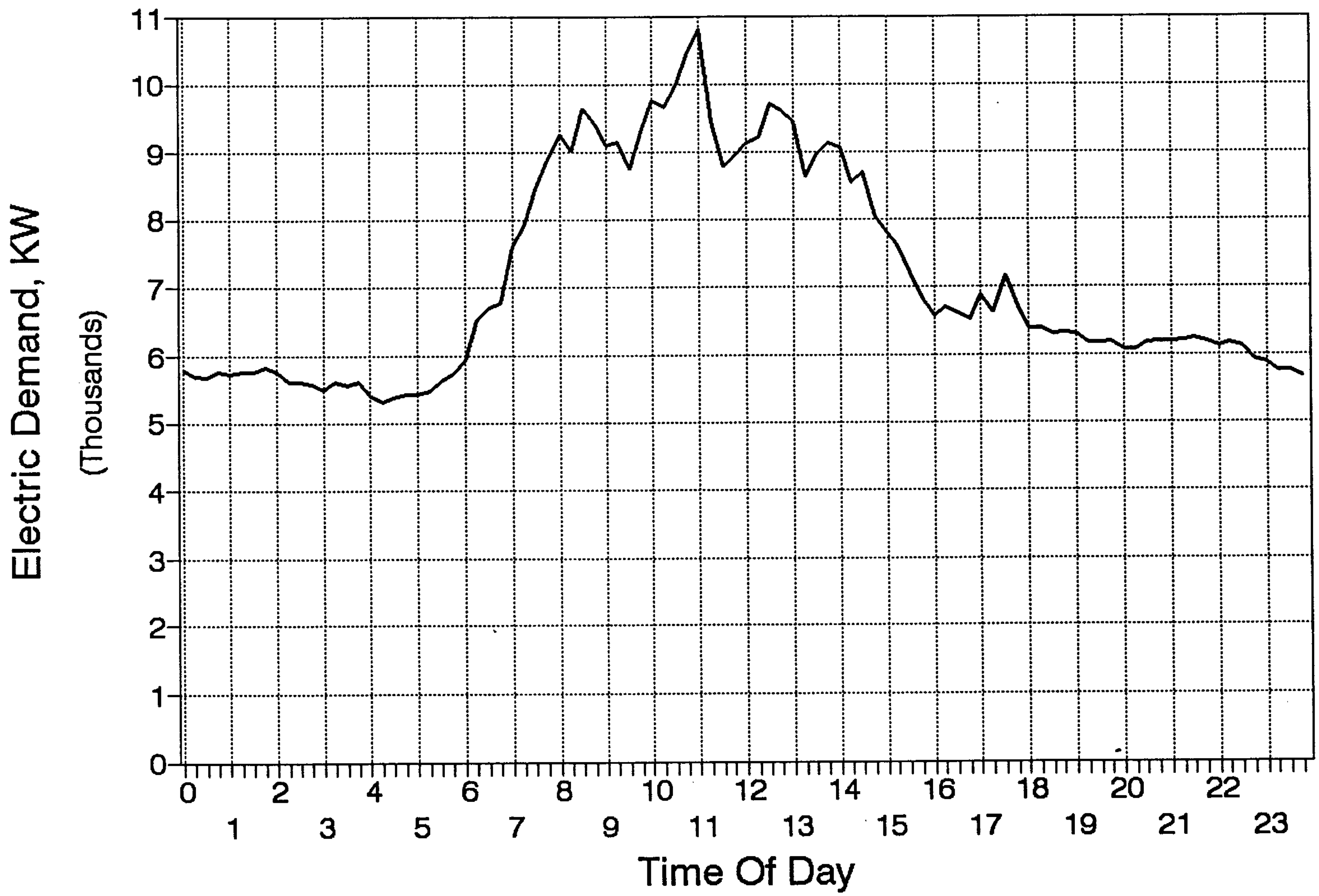


Figure 4-5-3

As illustrated by the example in the previous paragraph, significant energy cost savings can be achieved by reducing the peak demand. Load shifting, load shedding and on-site power generation are the methods by which peak demand reduction can be obtained.

Load shifting involves scheduling some of the operations that currently occur during peak demand periods to off-peak periods. This could include the shifting of some operations from daytime to nighttime, or scheduling the electrical intensive processes so they would not occur at coincident times throughout the day.

Load shedding for peak demand control consists of turning off machines, lighting and other noncritical electrical equipment during peak demand periods. This can be accomplished manually or with an integrated energy management system that utilizes microprocessor controls. This method of demand control can be effective in reducing peak electrical demand, but it may also adversely affect the productivity of the operations at WVA. Load shedding can provide good results for HVAC systems; however, turning off process equipment at unspecified times is not recommended.

On-site power generation for peak demand reduction involves replacing the power supplied by the electric utility with a base supply of electricity generated on site. This strategy is analyzed and discussed in ECO 3, Cogeneration.

Building 135 has five process operations that require large amounts of electricity. The five operations are the rotary forge (1,650 KW), Tocco furnaces (two stages, 1,250 KW and 625 KW), Selas furnace (636 KW), vertical furnaces (two stages 471 KW and 202 KW) and swage (227 KW). The lighting in Building 135 draws an additional 116 KW. Building 35 has two Wellman Furnaces that draw approximately 1,000 KW each. For this analysis, it was assumed that only one furnace operates for an eight-hour cycle, once a day, five days per week. There is also an abundance of machining equipment and smaller motor-driven loads in these buildings.

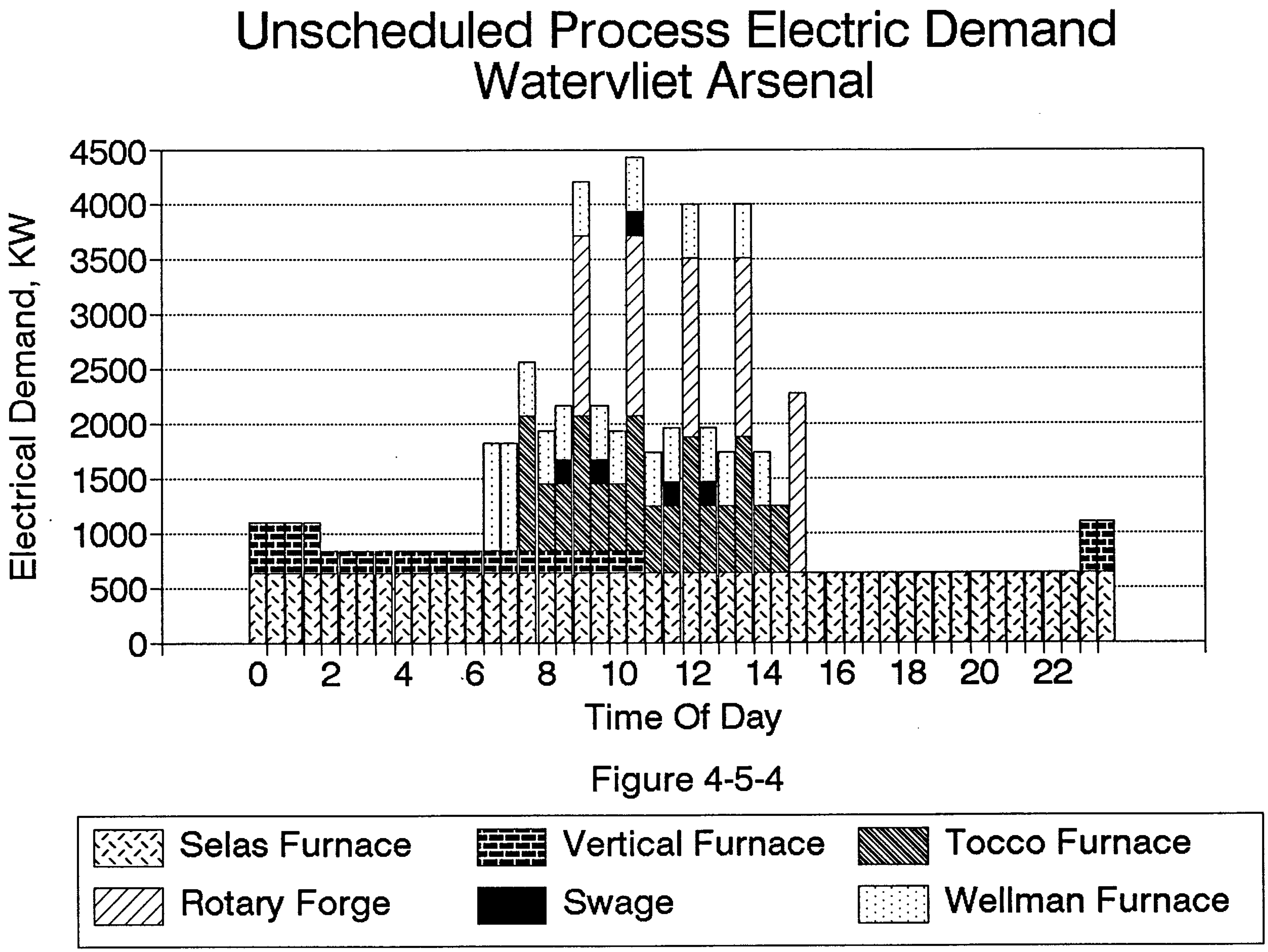

Unscheduled Process Electric Demand
Watervliet Arsenal
Electrical Demand, KW
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
16
18
20
22
Time Of Day
Selas Furnace
Vertical Furnace
Tocco Furnace
Rotary Forge
Swage
Wellman Furnace

Figure 4-5-4

Scheduled Process Electric Demand
Watervliet Arsenal

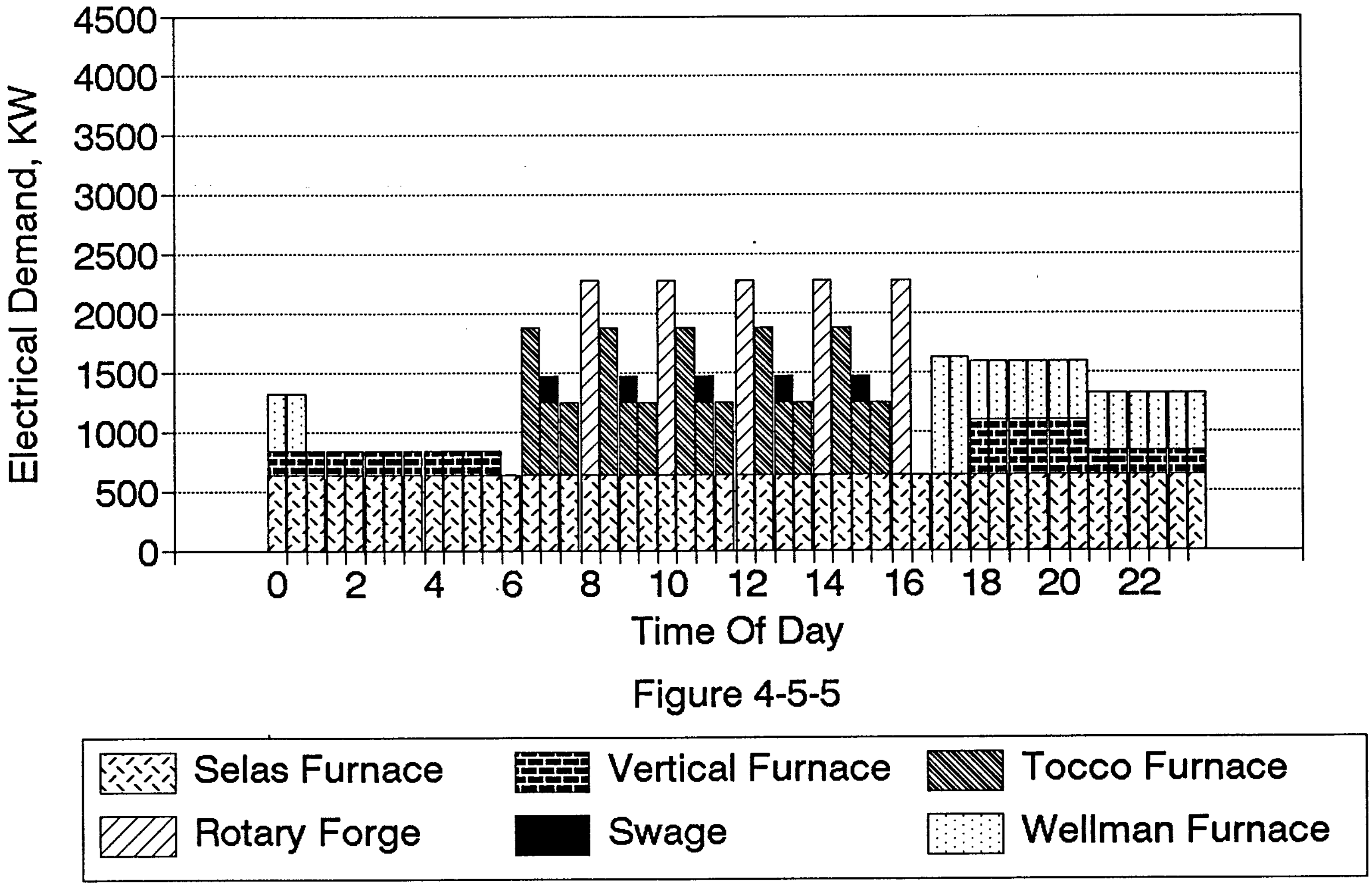


Figure 4-5-5

When these processes are allowed to run randomly, as shown by Figure 4-5-4, all of them could occur simultaneously. The resulting peak electrical demand (which in this figure occurs about 10:30 am) can be as high as 4,465 KW. However, by scheduling these operations to occur during specific intervals throughout the day (refer to Figure 4-5-5), the peak electrical demand for these operations can be maintained at about 2,285 KW. The difference between the two operating methods results in an electric demand reduction of approximately 2,180 KW. Reducing the on-peak demand by this amount each month would reduce WVA's annual electric cost by about $151,000.

Recommendation

Based on the electric utility cost savings, it is recommended that WVA utilize load shifting and process scheduling to reduce the peak electrical demand. There are no capital costs associated with this project.

Construction Cost	0
Annual Energy Savings (MBtu/year)	
Electricity	0
Natural Gas	0
Fuel Oil #2	0
Fuel Oil #6	0
Annual Energy Cost Savings ($/year)	$151,000
SIR	∞
Simple Payback (years)	0

ECO Number 6

PLATING AREA CONDENSATE RETURN

Discussion

Boiler feed water make-up for the main boiler plant in Building 136 currently averages about 35 percent. An extensive steam line and trap repair program is in progress that should lower this amount. However, most of the make-up is due to condensate that is dumped to waste from the plating areas in Building 35. Condensate is not returned from these areas because of the possibility of contamination by plating process chemicals.

The proposed project would return condensate from both plating areas in Building 35--gun tube chrome plating and small parts plating. It would consist of two systems--one for Building 136 main plant during heat season and the other for the Building 35 "donkey" boiler used in the summer time.

The proposed system would utilize existing condensate receivers in Building 35 and condensate return lines to Building 136 plus a completely new condensate receiver system and lines to the "donkey" boiler. Two pH sensors will be installed in each of the plating area condensate return headers. Three-way valves with actuators will divert condensate to waste when contamination of the condensate causes the pH to fall below a preset level. Radford Army Ammunition Plant in Radford, Virginia uses a similar system in one of their processing areas.

Recommendations

Based on the life cycle cost analysis, this ECO is recommended.

Construction Cost	$15,800
Annual Energy Savings (MBtu/year)	
Fuel Oil No. 6	2,255
Natural Gas	3,205
Annual Energy Cost Savings ($/year)	$23,300
SIR	24.1
Simple Payback (years)	0.8

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO6
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO # 6 PLATING AREA CONDENSATE RETURN
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: P. HUTCHINS

1. INVESTMENT

A. CONSTRUCTION COST	$	15766.
B. SIOH	$	946.
C. DESIGN COST	$	946.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	17658.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	0.	$ 0.	15.19	0.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	2255.	$ 9922.	18.56	184152.
D. NAT G	$ 4.16	3205.	$ 13333.	18.16	242124.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		5460.	$ 23255.		$ 426276.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 140671.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 23255.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 426276.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 24.14
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 .76

ECO Number 7

CONDENSER FAN VARIABLE-SPEED DRIVE

Discussion

Excess process water heat energy from the gun tube chrome plating area in Building 35 is currently removed by a closed-loop condenser. A single fan cycles on and off to cool the process water to 75°F. On the hottest summer days, a second fan is energized to assist in the heat removal.

An earlier analysis was performed based on continuous operation of one condenser fan using a by-pass valve to provide process water temperature control. An analysis showed a variable-speed drive on the condenser fan motor to be a cost effective method of reducing energy costs. Since then, review comments indicated that the process water temperature is controlled in a different manner. Instead of a by-pass valve, all process water is pumped through the condenser and one or two fans are energized as required to maintain the leaving water temperature. Since this method of operation cycles the fans on and off, a variable-speed drive would have very low potential savings.

Recommendations

A variable-speed drive would not save significant amounts of energy over the existing fan cycling control method. No further analysis is recommended.

This page is intentionally blank

This page is intentionally blank

ECO Number 8

HIGH-EFFICIENCY FLUORESCENT LAMPS AND BALLASTS

Discussion

The electric utility company serving Watervliet Arsenal, Niagara Mohawk Power Corporation (NMPC), in late calendar year 1990 proposed replacement of standard-wattage fluorescent lamps and ballasts with energy efficient types. The proposal involved both F-40 lamps, which draw 40 watts of power and are four feet in length, and high-output (HO) F-96 lamps, which draw 110 watts of power and are eight feet in length. Ballast replacements proposed were electronic types. In addition to the energy cost savings that would be realized by WVA by the replacements, NMPC offers cost rebates as added incentives to their customers.

NMPC proposed replacement of 8,256 F-40 lamps and 4,128 F-40 ballasts, and 2,368 F-96 lamps and 1,184 F-96 ballasts. The calculated energy savings would offset the cost of the replacements in less than two years based on annual operation of the F-40 lamps of 3,640 hours and 8,670 hours for the F-96 lamps. NMPC did not calculate any demand-cost savings, nor any installation costs, nor did NMPC designate the buildings surveyed.

To better quantify the savings to be realized from lamp and ballast replacements, the Reynolds, Smith and Hills, Inc. (RS&H) team surveyed four production facilities that are primarily lighted by fluorescent lamps--Buildings 20, 25, 110, and 125--and 13 support facilities--numbers 10, 15, 21, 23, 24, 40, 44, 115, 120, 123, 124, 130 and 145. Although it is difficult to determine the exact number of lamps and fixtures in each facility, a count was made in order to estimate the number and type of lamps and fixtures in each building. The lamp and ballast types were also checked by a review of records maintained by the electrical shop. Altogether, the surveyed facilities represent approximately 87 percent of WVA's total floor space. Details on fluorescent lights and fixtures in each building are contained in the Appendix.

Based on the tabulated lamps and ballasts, it was decided to only examine the predominant types, the F40T12 and the F96T12. The F90T12 lamps used in Building 20 are replacements for the standard F90T17 models, and are considered to be energy-efficient.

Since Buildings 20, 25, 110 and 125 are production areas, it was estimated that the lamps burn approximately 6,000 hours per year. Fourteen hours of a 24-hour day are charged at peak electric rates. Therefore, approximately 58 percent of the energy costs for lights in the three buildings are at the peak rates.

For the other buildings, it was assumed that the lamps were energized approximately 2,750 hours per year, with approximately 85 percent occurring during peak hours.

The life-cycle cost analysis program, LCCID, was used to determine the costs/benefits of lamp and ballast replacements. Material costs were taken from vendor quotes; installation labor costs were taken from Means Electrical Cost Data, 1991 edition. Non-energy benefits of NMPC rebates ($0.40 per lamp and $20.00 per ballast) were included in the analysis. Annual lamp replacement costs were also included.

Details on lamp and ballast specifications, construction cost estimates and screening calculations are contained in the Appendix.

Recommendations

Seven of the ten cases analyzed offer simple paybacks of less than ten years and therefore are qualified for project funding and recommended. However, three of the ten (8A, 8B and 8C) are variations of F-40 lamp and ballast replacement in production areas, and two of the ten (8G and 8H) are variations of F-96 lamp and ballast replacement in production areas.

Based on energy savings to WVA and construction costs, three of the ten ECOs (8C, 8D and 8H) are recommended to be combined into an ECIP. Results of the Life Cycle Cost Analysis are contained in Table 8-1.

TABLE 8-1 LCCID ANALYSIS RESULTS

ECO #	8A	8B	8C	8D	8E
Construction Cost ($)	1,900	11,600	9,900	49,600	298,800
Annual Energy Savings (MBtu/yr)					
Electricity	51	102	117	589	1,104
Natural Gas	0	0	0	0	0
Fuel Oil #2	0	0	0	0	0
Fuel Oil #6	0	0	0	0	0
Annual Cost Savings ($/yr)	970	2,100	2,400	11,300	24,900
SIR	6.8	2.6	3.3	3.1	1.2
Simple Payback (years)	2.2	6.1	4.7	4.9	13.4

ECO #	8F	8G	8H	8I	8J
Construction Cost ($)	340,700	61,000	346,400	10,100	51,200
Annual Energy Savings (MBtu/yr)					
Electricity	1,399	768	4,478	58	339
Natural Gas	0	0	0	0	0
Fuel Oil #2	0	0	0	0	0
Fuel Oil #6	0	0	0	0	0
Annual Cost Savings ($/yr)	30,600	13,200	91,200	1,000	7,100
SIR	1.3	3.0	3.6	1.4	1.8
Simple Payback (years)	12.5	5.2	4.3	11.2	9.0

ECO DESCRIPTIONS

8A - Install 34-watt lamps in production areas
8B - Install 34-watt lamps & energy electromagnetic ballasts in production areas
8C - Install 32-watt T-8 lamps & electronic ballasts in production areas
8D - Install 34-watt lamps in non-production areas
8E - Install 34-watt lamps & energy electromagnetic ballasts in non-production areas
8F - Install 32-watt T-8 lamps & electronic ballasts in non-production areas
8G - Install 60-watt lamps in production areas
8H - Install 60-watt lamps & electronic ballasts in production areas
8I - Install 60-watt lamps in non-production areas
8J - Install 60-watt lamps & electronic ballasts in non-production areas

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: EC08A
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.065
INSTALLATION & LOCATION: WVA — REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: 8A INSTALL 34W LAMPS; PRODUCTION AREAS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	1948.
B. SIOH	$	117.
C. DESIGN COST	$	117.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	2182.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	51.	$ 1038.	15.19	15765.
B. DIST	$ .00	0.	$ 0.	17.15	0.
C. RESID	$ .00	0.	$ 0.	18.56	0.
D. NAT G	$ .00	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		51.	$ 1038.		$ 15765.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -70.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -1028.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REBATES	$ 123.	1	.96	118.
d. TOTAL	$ 123.			118.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -910.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 5202.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 973.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 14855.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 6.81
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 2.24

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: EC08B
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WVA REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: 8B INSTALL 34W LAMPS/BLSTS; PROD AREAS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	11602.
B. SIOH	$	697.
C. DESIGN COST	$	697.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	12996.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	102.	$ 2076.	15.19	31530.
B. DIST	$ .00	0.	$ 0.	17.15	0.
C. RESID	$ .00	0.	$ 0.	18.56	0.
D. NAT G	$ .00	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		102.	$ 2076.		$ 31530.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -70.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -1028.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REBATES	$ 3163.	1	.96	3036.
d. TOTAL	$ 3163.			3036.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 2009.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 10405.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)_____
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 2132.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 33539.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.58
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 6.10

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: EC08C
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WVA REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: 8C INSTALL T-8 LAMPS/BLSTS; PROD AREAS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	9896.
B. SIOH	$	594.
C. DESIGN COST	$	594.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	11084.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	117.	$ 2381.	15.19	36167.
B. DIST	$ .00	0.	$ 0.	17.15	0.
C. RESID	$ .00	0.	$ 0.	18.56	0.
D. NAT G	$ .00	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		117.	$ 2381.		$ 36167.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -96.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -1409.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REBATES	$ 2203.	1	.96	2115.
d. TOTAL	$ 2203.			2115.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 706.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 11935.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 2373.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 36872.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 3.33
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 4.67

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO8D
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WVA REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: 8D INSTALL 34W LAMPS; NON-PRODUCTION AREAS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	49614.
B. SIOH	$	2977.
C. DESIGN COST	$	2977.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	55568.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	589.	$ 11986.	15.19	182070.
B. DIST	$ .00	0.	$ 0.	17.15	0.
C. RESID	$ .00	0.	$ 0.	18.56	0.
D. NAT G	$ .00	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		589.	$ 11986.		$ 182070.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -809.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -11876.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REBATES	$ 3138.	1	.96	3012.
d. TOTAL	$ 3138.			3012.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -8864.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 60083.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 11303.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 173206.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 3.12
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 4.92

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: EC08E
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WVA REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: 8E INSTALL 34W LAMPS/BLSTS; NON-PROD AREAS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	298823.
B. SIOH	$	17930.
C. DESIGN COST	$	17930.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	334683.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	1104.	$ 22466.	15.19	341265.
B. DIST	$ .00	0.	$ 0.	17.15	0.
C. RESID	$ .00	0.	$ 0.	18.56	0.
D. NAT G	$ .00	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		1104.	$ 22466.		$ 341265.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -809.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -11876.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REBATES	$ 81598.	1	.96	78334.
d. TOTAL	$ 81598.			78334.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 66458.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 112617.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 24921.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 407723.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.22
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 13.43

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: EC08F
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WVA REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: 8F INSTALL T-8 LAMPS/BLSTS; NON-PROD AREAS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	340723.
B. SIOH	$	20444.
C. DESIGN COST	$	20444.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	381611.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	1399.	$ 28470.	15.19	432454.
B. DIST	$ .00	0.	$ 0.	17.15	0.
C. RESID	$ .00	0.	$ 0.	18.56	0.
D. NAT G	$ .00	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		1399.	$ 28470.		$ 432454.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1133.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -16632.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REBATES	$ 81598.	1	.96	78334.
d. TOTAL	$ 81598.			78334.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 61702.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 142710.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 30601.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 494156.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.29
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 12.47

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: EC08G
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WVA REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: 8G INSTALL 60W LAMPS; PRODUCTION AREAS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	61029.
B. SIOH	$	3662.
C. DESIGN COST	$	3662.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	68353.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	768.	$ 15629.	15.19	237401.
B. DIST	$ .00	0.	$ 0.	17.15	0.
C. RESID	$ .00	0.	$ 0.	18.56	0.
D. NAT G	$ .00	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		768.	$ 15629.		$ 237401.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -2530.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -37140.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REBATES	$ 2499.	1	.96	2399.
d. TOTAL	$ 2499.			2399.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -34741.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 78342.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 13199.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 202660.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 2.96
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 5.18

LIFE CYCLE COST ANALYSIS SUMMARY   STUDY: ECO8H
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)   LCCID 1.065
INSTALLATION & LOCATION: WVA   REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: 8H   INSTALL 60W LMPS/ELECT BLSTS; PROD AREAS
FISCAL YEAR 1992   DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	346413.
B. SIOH	$	20785.
C. DESIGN COST	$	20785.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	387983.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	4478.	$ 91127.	15.19	1384224.
B. DIST	$ .00	0.	$ 0.	17.15	0.
C. RESID	$ .00	0.	$ 0.	18.56	0.
D. NAT G	$ .00	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		4478.	$ 91127.		$ 1384224.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -2530.
(1) DISCOUNT FACTOR (TABLE A)   14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -37140.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REBATES	$ 64979.	1	.96	62380.
d. TOTAL	$ 64979.			62380.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 25239.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 456794.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 91196.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1409463.

6. DISCOUNTED SAVINGS RATIO   (SIR)=(5 / 1E)=   3.63
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED)   SPB=1E/4   4.25

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: EC08I
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WVA REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: 8I INSTALL 60W LAMPS; NON-PRODUCTION AREAS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	10080.
B. SIOH	$	605.
C. DESIGN COST	$	605.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	11290.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	58.	$ 1180.	15.19	17929.
B. DIST	$ .00	0.	$ 0.	17.15	0.
C. RESID	$ .00	0.	$ 0.	18.56	0.
D. NAT G	$ .00	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		58.	$ 1180.		$ 17929.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$	-192.
(1) DISCOUNT FACTOR (TABLE A)	14.68		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	-2819.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REBATES	$ 413.	1	.96	396.
d. TOTAL	$ 413.			396.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -2422.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 5916.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 1005.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 15507.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.37
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 11.24

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: EC08J
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.065
INSTALLATION & LOCATION: WVA — REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: 8J INSTALL 60W LMPS/ELECT BLSTS; NON-PROD
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	57218.
B. SIOH	$	3433.
C. DESIGN COST	$	3433.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	64084.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	339.	$ 6899.	15.19	104790.
B. DIST	$ .00	0.	$ 0.	17.15	0.
C. RESID	$ .00	0.	$ 0.	18.56	0.
D. NAT G	$ .00	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		339.	$ 6899.		$ 104790.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -192.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -2819.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REBATES	$ 10733.	1	.96	10304.
d. TOTAL	$ 10733.			10304.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 7485.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 34581.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 7136.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 112276.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.75
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 8.98

ECO Number 10

HIGH-EFFICIENCY ELECTRIC MOTORS

Discussion

The plating of gun tubes and components requires a large number of electric motors to power pumps, exhaust fans, fume scrubbers, and blowers. Since most of the electric motors are energized 24 hours per day, replacement of the standard motors with high-efficiency offers an opportunity for energy and cost savings.

Two plating systems in Building 35 were examined; Small Parts Plating components and Medium Gun Tube Plating. The physical arrangement and the large number of motors made the collection of name-plate data very difficult. Instead, specific motor data were taken from the WVA system property records.

In order to estimate the cost-effectiveness of motor replacement, an estimated simple payback period was calculated for motors of three horsepower (HP) and larger. This preliminary calculation showed that replacement of motors of 100 HP and less would be cost effective.

In all, there are 67 motors in the two areas (35 in the Small Parts Plating area and 32 in the Medium Tube Plating area) that are of sizes that could be replaced. The most numerous are the 10 and 20 HP sizes, totaling 11 and 13, respectively. Motors in the Small Parts Plating area are used five days per week; those in the Medium Tube Plating area are used seven days per week.

The life-cycle cost analysis program, LCCID, was used to determine the costs/ benefits of motor replacements in the two production areas. Material costs were taken from the 1991 Reliance Electric Company catalog; installation labor costs were taken from Means Electrical Cost Data, 1991 edition. Non-energy benefits of peak demand savings (each year) were included in the analysis.

Electric energy rates were calculated depending on the relative amounts of time the motors were operated during on-peak and off-peak hours. Details are contained in the Appendix.

Recommendations

Based on the life-cycle cost analysis, the project qualifies for funding and is recommended.

Construction Cost	$104,931
Annual Energy Savings (MBtu/year)	
Electricity Energy	1,602
Annual Cost Savings ($/year)	$32,600
SIR	4.2
Simple Payback (years)	3.6

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO10
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO 10 INSTALL HIGH EFFICIENCY ELECTRIC MOTORS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	104931.
B. SIOH	$	6296.
C. DESIGN COST	$	6296.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	117523.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 15.03	1901.	$ 28572.	15.19	434009.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	0.	$ 0.	18.56	0.
D. NAT G	$ 4.16	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		1901.	$ 28572.		$ 434009.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 4402.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 64621.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
d. TOTAL	$ 0.			0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 64621.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 143223.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 32974.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 498631.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 4.24
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 3.56

ECO Number 11

BOILER O_2 TRIM CONTROLS

Discussion

The "Energy Management Proposal" developed by the Niagara Mohawk Power Corporation, 10/91, recommended boiler O_2 trim controls for boilers numbered 2, 4 and 5. Discussion with the WVA boiler plant personnel indicated the following plans for the main boiler plant.

- o Boilers #1 and #2 (35,000 lbs/hr) are to be removed
- o Boiler #3 (110,000 lbs/hr) has O_2 trim controls recently fitted, plus a dual-fuel burner (natural gas and No. 6 fuel oil) with a ten to one turn-down ratio

With its capacity and large turn-down ratio, Boiler #3 is planned to be operated alone with Boiler #4 (110,000 lbs/hr) and #5 (25,000 lbs/hr) to be used as backup steam suppliers. This procedure would allow for only minimal operation of #4 and #5 boilers. Therefore O_2 trim controls are not recommended.

ECO Number: 12

REPLACE ELECTRIC BOILERS WITH NATURAL GAS BOILERS

Discussion

Buildings 40, 44 and 125 all contain small electric boilers. These boilers are primarily used for humidification of certain areas of their respective buildings. On a dollar-per-BTU basis, electricity is currently the most expensive energy source used at WVA and natural gas is the least expensive. Replacing the existing electric boilers with new boilers that utilize natural gas would result in a substantial energy cost savings.

This ECO calls for the removal of the existing electric boilers and the installation of new natural gas-fired boilers with the associated piping and controls. Natural gas lines are already available in Buildings 40 and 125, and there is a natural gas line approximately 150 feet from Building 44.

The existing electric boiler sizes are 90 kW in Building 40, 210 kW in Building 44, 58 kW in building 125-North and 58 kW in Building 125-South.

The new natural gas boilers would actually use more energy than the existing boilers due to the difference in conversion efficiency. Electricity has a 100-percent conversion efficiency compared with an 80-percent conversion efficiency for natural gas. However, the price difference between electricity and natural gas will generate utility cost savings.

The hours of operation of these boilers were estimated using a spreadsheet computer program. The computer program uses published bin temperature data (dry bulb range and mean coincident wet bulb) for Albany, NY.

Recommendation

The net result of this ECO would be an increase in overall energy use; however, based on the energy cost savings and the life cycle cost analysis, it is recommended that the electric boilers in Buildings 40, 44 and 125 be replace with new natural gas-fired boilers.

Construction Cost	$44,592
Annual Energy·Savings (MBtu/Yr)	
Electricity	2,497
Natural Gas	-3,122
Annual Energy Cost Savings ($/Yr)	$37,826
SIR	10.7
Simple Payback (years)	1.3

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: EC012
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO 12 REPLACE ELEC. BOILERS WITH NATURAL GAS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$	44592.
B. SIOH	$	2676.
C. DESIGN COST	$	2676.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	49944.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	2497.	$ 50814.	15.19	771864.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	0.	$ 0.	18.56	0.
D. NAT G	$ 4.16	-3122.	$ -12988.	18.16	-235853.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		-625.	$ 37826.		$ 536011.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 176883.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 37826.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 536011.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 10.73
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 1.32

ECO Number: 13

AIR FLOW REDUCTION

Discussion

Air Handling unit number 1 (AHU-1) provides cooling, heating and ventilation air for the ground floor, first floor and the mezzanine area of Building 120. Field measurements indicated that the actual air flow was approximately 15 percent higher than the design air flow. This excess air flow must be heated in the winter, cooled in the summer and blown through the supply/return distribution system all year long. Energy savings can be achieved by rebalancing the fan to AHU-1 to its original design standards.

AHU-1 is located in the mechanical equipment room/storage room, next to the wood shop on the first floor. It is a multizone type unit with service to eight different zones. The design air flow based on the "As-Built" drawings is 6,250 cubic feet per minute (cfm) with a minimum of 930 cfm of outside air.

Air pressure measurements were taken on each of the supply air ducts. The total calculated air flow was 8,250 cfm, which is 1,980 cfm greater than the design air flow. Using the same percentage increase means that approximately 1,225 cfm of outside air is being drawn in by AHU-1.

The energy use required to heat and cool the excess outside air was calculated using a spreadsheet computer program. The computer program uses published bin temperature data (dry bulb range and mean coincident wet bulb) for Albany, NY.

There will also be some additional electricity savings due to the reduced load on the fan motor. The revolutions per minute (RPM) of the fan can be reduced proportionally to the reduction in the total air flow through the fan.

This ECO consists of balancing the air flow quantities for each supply air zone, the return air system, the outside air intake and the fan for

AHU-1. This action would make sure that the correct amount of outside air is being utilized and the proper amount of heating, cooling and ventilation air is being distributed to each area.

Recommendation

Based on the energy cost savings and the life cycle cost analysis, it is recommended that AHU-1 be rebalanced to provide the proper amount of outside air, return air and supply air.

Construction Cost	$914
Annual Energy Savings (MBtu/Yr)	
Electricity	31
Fuel Oil No. 6	25
Annual Energy Cost Savings ($/Yr)	$741
SIR	11.4
Simple Payback (years)	1.4

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO13
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO 13 REDUCE AIR FLOW - BUILDING 120
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$	914.
B. SIOH	$	55.
C. DESIGN COST	$	55.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	1024.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	31.	$ 631.	15.19	9583.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	25.	$ 110.	18.56	2042.
D. NAT G	$ 4.16	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		56.	$ 741.		$ 11624.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3836.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 741.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 11624.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 11.35
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 1.38

ECO Number: 14

HIGH-EFFICIENCY CHILLER

Discussion

There are two electrically driven centrifugal chillers located in the mechanical equipment room at the south end of Building 115. The capacity of these chillers is 185 tons each and they are approximately 20 years old. The efficiency of the chillers manufactured at that time was between 1.0 kW per ton of cooling (kW/ton) and 1.2 kW/ton. Replacing one of these old chillers with a new, more efficient chiller would save some of the energy (electricity) required to cool Building 115.

Discussions with the mechanical maintenance staff indicated that under normal conditions, only one of these chillers is operated and the other is used as a backup. This ECO consists of removing one of the existing chillers and replacing it with a new centrifugal chiller.

In the years since the existing chillers were manufactured, new technology has improved chiller efficiencies. The efficiency of new electric centrifugal chillers is approximately 0.7 kW/ton.

This analysis assumed that cooling would be required in Building 115 when the outside air temperature rises above about 57°F. Published bin temperature data for Albany, NY, shows that on average the outside air temperature is at or above 57°F for about 3,594 hours per year.

Recommendation

Based on the life cycle cost analysis, this ECO is not recommended. The electric energy cost savings do not defray the high initial cost of replacing the chiller.

Construction Cost	$133,192
Annual Energy Savings (MBtu/Yr)	
Electricity	363
Annual Energy Cost Savings ($/Yr)	$7,387
SIR	0.8
Simple Payback (years)	20.2

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO14
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO 14 REPLACE OLD CENTRIFUGAL CHILLER
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$	133192.
B. SIOH	$	7992.
C. DESIGN COST	$	7992.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	149176.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	363.	$ 7387.	15.19	112209.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	0.	$ 0.	18.56	0.
D. NAT G	$ 4.16	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		363.	$ 7387.		$ 112209.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 37029.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 7387.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 112209.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= .75
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 20.19

ECO Number: 15

ENERGY MONITORING AND CONTROL SYSTEMS

Discussion

An Energy Monitoring and Control System (EMCS) is a computer-based system that can be used to automatically monitor and control various functions of a building's energy using equipment. The EMCS consists of a Central Control Unit (CCU), Field Interface Devices (FID), multiplexers (MUX), Data Transmission Media (DTM) and software to provide instructions for the various control and monitoring functions.

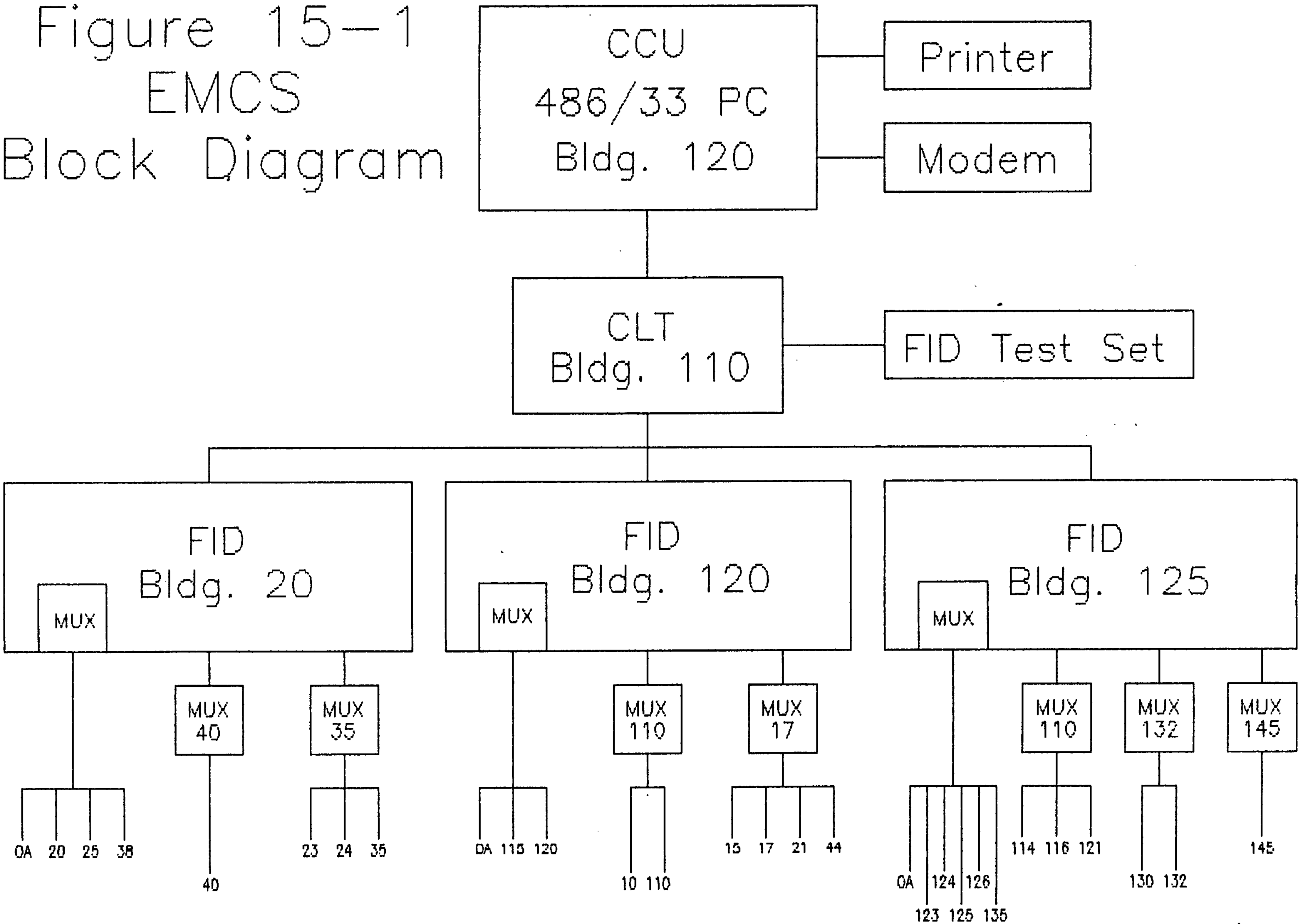
A block diagram of the EMCS proposed for use at WVA is shown on the following page (Figure 15-1). The CCU in this case is a Personal Computer with a 486 microprocessor operating at 33 Megahertz. The CCU uses a dial-up telephone modem to communicate with the FIDs through the Communication Link Termination (CLT). The three FIDs, which also contain microcomputers, are located in Buildings 20, 120 and 125. The MUX sends commands from the FID to the control devices attached to the HVAC equipment. Each FID includes one MUX; however, additional remotely located MUXs are utilized to control other buildings.

Energy savings can be achieved at WVA by utilizing the EMCS to control the heating, ventilating and air conditioning (HVAC) equipment in many of the buildings. This analysis considers controlling some of the HVAC equipment in Buildings 10, 15, 17, 20, 21, 23, 24, 25, 35, 38, 40, 44, 110, 114, 115, 116, 120, 121, 123, 124, 125, 126, 130, 132, 135 and 145.

The control programs (software) that can be effectively utilized at WVA are variations of the Ventilation and Recirculation Program and the Day/Night Setback Program. These programs are briefly explained in the following paragraphs. Other functions including optimal start-stop were evaluated but were not cost effective.

Demand Limiting. Demand limiting is accomplished by shedding electrical loads to prevent electrical demand from exceeding a peak value (target). When the predicted peak approaches preset limits, certain scheduled

Figure 15—1
EMCS
Block Diagram



electrical loads with pre-established groups are de-energized on a priority basis. The strategy is to shed approximately one-fourth of the total controlled load for 7.5 minutes. After 7.5 minutes, this group is energized and another group representing about one-fourth of the total controlled load is de-energized. This continues until the electricity demand drops below the preset target value. This procedure reduces the demand by one-fourth the controlled load and de-energizes no single load for more than 15 minutes per hour or 7.5 minutes continuously.

The loads selected for shedding at WVA are eight large electrical chillers varying from 30 to 185 tons. The total controlled load is 709 tons.

Ventilation and Recirculation. The ventilation and recirculation program controls the operation of the outside air (OA) damper when the introduction of OA would impose an additional thermal load during warm-up cycles prior to occupancy of the building. During unoccupied periods, the OA dampers remain closed. During building occupied cycles, the OA, return and relief dampers are under local loop control. Energy savings are obtained by reducing the amount of outside air that is currently being heated prior to the building's occupied hours.

Day/Night/Weekend Setback. The energy required for space heating during unoccupied hours is reduced by shutting off the equipment and allowing the space temperature to decrease. The space temperature can be reduced from the normal winter inside design temperature to a lower space temperature during the unoccupied hours. The normal temperature setting is resumed prior to occupancy of the building. This applies to buildings or areas that do not operate 24 hours a day, seven days a week.

The equipment that will be controlled includes valves for steam radiation and hot water heating systems, and pumps for hot water heating systems. This ECO will take advantage of the approximately 27 existing steam valves that are controlled manually.

Recommendation

Early involvement of activity operation and maintenance personnel is a key ingredient to a successful EMCS application. In order for an EMCS project to be included in the annual ECIP Military Construction Program request to Congress, the project documentation must include a formal commitment by the receiving activity that appropriate staff will be assigned to the project within 90 days of award of the construction contract.

The EMCS evaluation documented herein is based on guidelines provided by the Corps of Engineers, Huntsville Division. Energy savings were calculated using Standardized EMCS Energy Savings Calculations, CR 82.030, 9/82. The document EMCS, Large and Medium Configuration, Cost Estimating Guidelines, CEHND-SP-90-244-ED-ME, 12/90 was utilized for cost estimates.

Based on the energy and maintenance savings, and the life cycle cost analysis, this ECO is not recommended.

Construction Cost	$493,300
Annual Energy Savings (MBtu/Yr)	
Electricity	--
Fuel Oil No. 6	9,851
Annual Energy Cost Savings ($/Yr)	$49,600
Annual Electricity Demand Savings ($/Yr)	$5,100
Annual Maintenance Cost Savings ($/Yr)	$1,100
SIR	1.1
Simple Payback (years)	11.2

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: ECO15
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO #15 ENERGY MONITORING AND CONTROL SYSTEM
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 08-24-92 ECONOMIC LIFE 15 YEARS PREPARED BY: P. HUTCHINS

1. INVESTMENT

A. CONSTRUCTION COST	$	493300.
B. SIOH	$	29598.
C. DESIGN COST	$	29598.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	552496.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	0.	$ 0.	10.88	0.
B. DIST	$ 5.00	0.	$ 0.	11.53	0.
C. RESID	$ 4.40	9851.	$ 43344.	12.42	538338.
D. NAT G	$ 4.16	0.	$ 0.	11.62	0.
E. COAL	$ .00	0.	$ 0.	11.87	0.
F. TOTAL		9851.	$ 43344.		$ 538338.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 6224.
(1) DISCOUNT FACTOR (TABLE A) 10.67
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 66410.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 66410.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 177651.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 49568.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 604748.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.09
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 11.15

ECO Number: 16
RETURN AIR SYSTEM

Discussion

Heating and ventilating unit number 1 (HV-1) is located in the basement mechanical equipment room of Building 44. This unit was originally designed to utilize 100 percent outside air for ventilation of the basement areas. The unit has been modified to return about 30 percent air through transfer grills. During the winter, the outside air is heated by a hot water coil to maintain the basement temperature at about 68°F.

The hot water is produced by a steam-to-hot water converter located in the heating equipment room. The converter uses steam from the central steam plant. Heating energy, which is the fuel oil No. 6 burned to generate the steam, can be saved by adding a return air system and reducing the amount of outside air to HV-1. Additional energy savings can be achieved by reducing the basement temperature to 55°F during unoccupied hours.

This project was originally designed and submitted by Planning Research Corporation (PRC) in 1981. The analysis that follows is an update of PRC's original project with some minor changes to account for current operating conditions. The construction cost estimate was updated to allow for inflation, and current energy cost data was used to calculate the savings.

The basement area is fully occupied Monday through Friday between 7 AM and 4 PM, partially occupied between 4 PM and 12 midnight, and unoccupied from 12 midnight to 7 AM and all day during weekends. HV-1 operates 24 hours per day, seven days per week. The current winter ventilation mode of HV-1 utilizes approximately 30 percent return air and 70 percent outside air. The return air enters HV-1 via a transfer grille through the heating equipment room and through an opening in the door to the mechanical equipment room.

This project includes the addition of a return air plenum and ductwork, modifications to the outside air plenum, and the addition of mixing dampers and controls to modulate the amounts of return air, outside air and exhaust air. Controls will also be added to reduce the temperature of the basement during unoccupied hours. The fan for HV-1 will be adjusted to account for the increased pressure drop due to the addition of the return air system. It is anticipated that the increased electricity consumption by this fan motor will be offset by the reduced operating times of the various basement exhaust fans.

The air quantity flow rates for HV-1 and the basement exhaust fans are shown in the following table. The flows are listed in cubic feet per minute (cfm) for the current operating modes and the new recommended ventilation modes.

BASEMENT/HV-1 AIR FLOWS (CFM)

Fan No. and Location		Existing Modes --MER Damper-- Open	Closed	New Ventilation Modes Min	Med	Max
E1	East	0	4,850	0	0	4,850
E2	East	2,430	2,430	0	0	2,430
E3 or E6	East	1,200	1,200	1,200	1,200	1,200
E13	East	4,850	4,850	0	4,850	4,850
E15	East	2,430	2,430	0	2,430	2,430
E18	East	200	200	200	200	200
E7 or E5	Center	7,520	11,280	3,760	7,520	11,280
E16	Storage	827	827	827	827	827
E4	west	9,820	9,820	0	0	9,820
Total Exhaust Air		29,277	37,887	5,987	14,597	37,887
HV-1 Outside Air		24,073	34,390	5,800	14,272	34,390
HV-1 Return Air		10,317		28,590	20,118	0
HV-1 Supply Air		34,390	34,390	34,390	34,390	34,390
Net Air Flow		-5,204	-3,497	-187	-325	-3,497

MER - mechanical equipment room.

The new recommended operating schedule for ventilation modes of the exhaust fans and HV-1 is shown in the following table. The basement temperature will be maintained at 68°F during the medium and maximum operating modes, and then set back to 55°F during the minimum operating mode.

RECOMMENDED VENTILATION SCHEDULE

Daily Shift Hours	Vent. Mode	Hours of Operation						
		Mon	Tue	Wed	Thu	Fri	Sat	Sun
12M-8AM	Min	7	7	7	7	7	8	8
	Med	1	1	1	1	1	0	0
	Max	0	0	0	0	0	0	0
8AM-4PM	Min	0	0	0	0	0	8	8
	Med	6	6	6	6	6	0	0
	Max	2	2	2	2	2	0	0
4PM-12M	Min	0	0	0	0	0	8	8
	Med	8	8	8	8	8	0	0
	Max	0	0	0	0	0	0	0

The project implementation cost was originally estimated by PRC using 1980 prices. Their estimate was updated using the Engineering News-Record (ENR) Building Cost Index (BCI) to escalate the 1980 prices to mid-1991 values.

Recommendation

Based on the heating energy cost savings and the life cycle cost analysis, it is recommended that a return air system and associated controls be installed on the basement heating and ventilating system in Building 44.

Construction Cost	$62,731
Annual Energy Savings (MBtu/Yr)	
Fuel Oil No. 6	3,985
Annual Energy Cost Savings ($/Yr)	$17,400
SIR	4.6
Simple Payback (years)	4.0

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECO16
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO 16 ADD RETURN AIR & REDUCE OUTSIDE AIR
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$	62731.
B. SIOH	$	3764.
C. DESIGN COST	$	3764.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	70259.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	0.	$ 0.	15.19	0.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	3985.	$ 17534.	18.56	325431.
D. NAT G	$ 4.16	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		3985.	$ 17534.		$ 325431.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 107392.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 17534.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 325431.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 4.63
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 4.01

ECO Number 17

DOUBLE-PANE WINDOWS

Discussion

Many of the buildings at WVA have single-pane windows. Heating energy (fuel oil No. 6) and cooling energy (electricity) consumption can be reduced by replacing the existing windows with double-pane insulating-type windows. Double-pane windows have two sheets of glass with a sealed air (or other inert gas) space between them. The second layer of glass and the air space increases the insulating characteristics of the window.

Heating and cooling load calculations were performed using a spreadsheet computer program with bin temperature data from Albany, NY. A standard two-foot, eight-inch-wide by six-foot, eight-inch-high, aluminum frame window was used for the energy savings and economic analysis calculations. According to 1989 ASHRAE Fundamentals Handbook, the addition of double-pane windows will improve the overall U-Value from 1.31 Btu/Hr*SqFt*°F to 0.70 Btu/Hr*SqFt*°F.

Recommendations

The life cycle cost analysis indicates a long payback, therefore installation of double-pane windows is not recommended at this time.

Construction Cost	$476
Annual Energy Savings (MBtu/year)	
Electricity	0.02
No. 6 Fuel Oil	2.55
Annual Energy Cost Savings ($/year)	$12
SIR	0.4
Simple Payback (years)	45.9

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: EC017
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO #17 DOUBLE PANE WINDOWS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-07-92 ECONOMIC LIFE 25 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$	476.
B. SIOH	$	29.
C. DESIGN COST	$	29.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	534.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	0.	$ 0.	15.19	6.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	3.	$ 11.	18.56	208.
D. NAT G	$ 4.16	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		3.	$ 12.		$ 214.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 71.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 12.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 214.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= .40
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 45.93

ECO Number 18

STORM WINDOWS

Discussion

Many of the buildings at WVA have single-pane windows. Heating energy (fuel oil No. 6) and cooling energy (electricity) consumption can be reduced by adding storm windows to the existing windows. A storm window is basically another window installed next to the existing window. The addition of this second layer of glass increases the insulating value of the window, making it similar to a double-pane window.

Heating and cooling load calculations were performed using a spreadsheet computer program with bin temperature data from Albany, NY. A standard two-foot, six-inch-wide by five-foot-high, double hung, aluminum frame window was used for the energy savings and economic analysis calculations. According to 1989 ASHRAE Fundamentals Handbook, the addition of double-pane windows will improve the overall U-Value from 1.31 Btu/Hr*SqFt*°F to 0.70 Btu/Hr*SqFt*°F. It was assumed that the addition of storm windows would improve the overall U-Value to 0.80 Btu/Hr*SqFt*°F.

Recommendations

The life cycle cost analysis indicates a payback of slightly more than 10 years, therefore installation of storm windows could only be funded by MCA dollars (plus the project must exceed $200,000, see Section 5.0). Because of the historical value of many of the WVA buildings it would not be likely to generate a project of this magnitude. Therefore, this project is not recommended.

Construction Cost	$101
Annual Energy Savings (MBtu/year)	
Electricity	0.01
No. 6 Fuel Oil	2.55
Annual Energy Cost Savings ($/year)	$11
SIR	1.8
Simple Payback (years)	10.5

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: EC018
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO #18 STORM WINDOWS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-07-92 ECONOMIC LIFE 25 YEARS PREPARED BY: W. TODD

1. INVESTMENT

A. CONSTRUCTION COST	$	101.
B. SIOH	$	6.
C. DESIGN COST	$	6.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	113.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	0.	$ 0.	15.19	6.
B. DIST	$ 5.00	0.	$ 0.	17.15	0.
C. RESID	$ 4.40	2.	$ 10.	18.56	192.
D. NAT G	$ 4.16	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		2.	$ 11.		$ 198.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.68
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 0.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 65.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 11.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 198.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 1.75
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 10.51

ECO Number 19

OCCUPANCY SENSORS

Discussion

Intermittently used areas are notorious for energy waste when lights are left on and no one is present. This is especially true of areas that are accessed by a variety of individuals such as rest rooms, break areas, conference rooms, etc.

Occupancy sensors can be used to automatically de-energize lights when areas are unoccupied. The analysis performed has shown that rest room areas are the most cost effective for the sensors. Ultrasonic, ceiling-mounted types are recommended because they do not require "line-of-sight" to detect motion as do passive infra-red types.

Recommendations

Based on the life cycle cost analysis, this ECO is recommended. The results are shown below.

Construction Cost	$11,279
Annual Energy Savings (MBtu/year)	
Electricity	211
Annual Energy Cost Savings ($/year)	$4,600
SIR	5.5
Simple Payback (years)	2.8

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: EC019
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: WATERVLIET AR.REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECO #19 OCCUPANCY SENSORS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 04-01-92 ECONOMIC LIFE 25 YEARS PREPARED BY: P. HUTCHINS

1. INVESTMENT

A. CONSTRUCTION COST	$	11279.
B. SIOH	$	677.
C. DESIGN COST	$	677.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	12633.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	211.	$ 4294.	15.19	65224.
B. DIST	$ .00	0.	$ 0.	17.15	0.
C. RESID	$ .00	0.	$ 0.	18.56	0.
D. NAT G	$ .00	0.	$ 0.	18.16	0.
E. COAL	$ .00	0.	$ 0.	17.34	0.
F. TOTAL		211.	$ 4294.		$ 65224.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$	0.
(1) DISCOUNT FACTOR (TABLE A)	14.68		
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$	0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REPLACEMENT	$ 7670.	12	.58	4449.
d. TOTAL	$ 7670.			4449.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 4449.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 21524.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 4601.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 69672.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 5.52
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 2.75

4.2 Multiple ECO Project Evaluations

ECIP Number 1. ECOs 8A through 8J represent a variety of measures for saving energy using high-efficiency fluorescent lamps and fixtures. There are three basic combinations evaluated for replacement:

- Four-foot fluorescents in production areas
- Four-foot fluorescents in non-production areas
- Eight-foot fluorescents in production areas

ECOs 8C, 8D and 8H were selected based on the life cycle cost analysis and combined into a single Energy Conservation Investment Program (ECIP) project.

ECIP Number 1

HIGH-EFFICIENCY LIGHTING

Discussion

Fluorescent lights use significant portions of Watervliet Arsenal's (WVA) electricity monthly demand and annual energy usage, being 12 to 13 percent of the respective totals. The electric company serving WVA, Niagara Mohawk Power Company (NMPC), proposed in late calendar year 1990 the replacement of some of the fluorescent lamps and ballasts to save energy and to take advantage of NMPC rebates of $0.40 per lamp and $20.00 per ballast.

At the request of WVA, the Reynolds, Smith and Hills, Inc. (RS&H) team surveyed facilities that used fluorescent lighting to determine if replacement of lamps and ballasts would fit energy-project funding criteria. The primary buildings used for manufacturing support and administration, manufacturing, and storage were surveyed; family housing was not included. Data from each building surveyed are contained in the Appendix.

Ten combinations of energy-efficient lamps and ballasts were examined to determine the potential for Energy Conservation Opportunities (ECOs). Details of the calculations are contained in ECO 8.

Of the ten combinations, three have been combined into a project that qualifies for ECIP funding. The project involves:

1. Installation of T-8, 32-watt lamps and electronic ballasts in place of 40-watt lamps and electromagnetic ballasts in the production areas (ECO 8C);
2. Installation of 60-watt lamps and electronic ballasts in place of 75-watt lamps and electromagnetic ballasts in the production areas (ECO 8H); and
3. Installation of 34-watt lamps in place of 40-watt lamps in the non-production areas (ECO 8D).

Recommendations

Based on the benefits and life cycle cost analysis, it is recommended that WVA install energy-efficient fluorescent lamps and ballasts in selected areas of the Arsenal.

Construction Cost	$454,634
Annual Energy Savings (MBtu/year)	
Electricity	5,184
Annual Energy Cost Savings ($/year)	$104,872
SIR	3.6
Simple Payback (years)	4.3

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: ECIP1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.062
INSTALLATION & LOCATION: WVA REGION NOS. 2 CENSUS: 1
PROJECT NO. & TITLE: ECIP1 REPLACE LAMPS AND BALLASTS
FISCAL YEAR 1992 DISCRETE PORTION NAME: TOTAL PROJECT
ANALYSIS DATE: 02-19-92 ECONOMIC LIFE 25 YEARS PREPARED BY: C. WARREN

1. INVESTMENT

A. CONSTRUCTION COST	$	455192.
B. SIOH	$	27312.
C. DESIGN COST	$	27312.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	509816.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 20.35	5356.	$ 108995.	15.11	1646908.
B. DIST	$ .00	0.	$ 0.	21.31	0.
C. RESID	$ .00	0.	$ 0.	25.22	0.
D. NAT G	$ .00	0.	$ 0.	20.70	0.
E. COAL	$ .00	0.	$ 0.	15.93	0.
F. TOTAL		5356.	$ 108995.		$ 1646908.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ -3463.
(1) DISCOUNT FACTOR (TABLE A)	14.53	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ -50317.

B. NON RECURRING SAVINGS(+) / COSTS(-)

ITEM	SAVINGS(+) COST(-) (1)	YR OC (2)	DISCNT FACTR (3)	DISCOUNTED SAVINGS(+)/ COST(-)(4)
1. REBATES	$ 78973.	1	.96	75814.
d. TOTAL	$ 78973.			75814.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ 25497.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 543480.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1F)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 108691.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 1672405.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1F)= 3.28
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1F/4 4.69

4.3 Operations and Maintenance Energy Savings

4.3.1 Energy Savings Ideas. As a result of the site visit to WVA, several operations and maintenance (O&M) energy savings ideas were identified. Energy and economic analyses were performed for these recommendations. The results of these analyses are presented below. Calculations for energy savings can be found in Volume II, Appendix B, under O&M Recommendations.

Upon Failure, Replace Standard Fluorescent Lamps with Energy-Efficient Types

Current practice is to replace failed fluorescent lamps with standard 40-watt lamps. Replacing failed lamps with 34-watt lamps saves about $0.95 per year for each lamp in office areas and $3.40 in production buildings. The incremental cost is the difference between the cost of the two lamps, which is $0.81 per lamp. This yields a payback of about 0.9 years for administrative areas and 0.25 for production.

Upon Failure, Replace Standard Fluorescent Fixture Ballasts with Energy-Efficient Types

Currently, fluorescent fixtures at Watervliet Arsenal use standard-efficiency ballasts. When a failure occurs, the standard ballast should be replaced with an electronic ballast. Energy savings for two lamp fixtures are 25 watts for four-foot models and 45 watts for the eight-foot type. Paybacks vary from 0.4 years in production areas to about 1.2 years in non-production.

Increase Boiler Condensate Return

A review of boiler logs shows that the condensate return for the main boiler plant averages about 60 percent. During our site surveys, a number of steam leaks and failed traps were found that can account for much of this. Locations are listed below and were identified by WVA maintenance personnel.

Buildings	Location
44	Mechanical room
34	Roof vent
40	Vent from wing near clinic
35	Roof--southwest corner
35	Exterior well south-middle
88	Roof vent--northwest corner

110	Roof vent--northwest side
110	Roof vent--southeast side
110	Roof vent--west middle
20	Roof vent--south side

Improving the condensate return to 90 percent is an achievable goal. This would require an increase in staffing at least on a temporary basis or utilizing a contractor. Annual savings of 7,100 MBtu of fuel oil costing $47,000 could be realized.

Repair Compressed Air Leaks

Throughout the production buildings, compressed air leaks were found. Generally, the leaks occur at fittings or filters. Also, many hose attachments have been made using screw-clamps. These are not recommended as they have a tendency to cut into the hose which is carrying 100 psi air. Many leaks and clamps were identified by WVA maintenance personnel. Repairing one compressed air leak saves about 6,300 kWh (22 MBtu) of electricity each year costing $440.

5.0 ENERGY PLAN

5.1 Project Packaging

The ECOs listed in Table 4-2 were evaluated for appropriate funding category. The project scope of work listed the following guidelines on this subject.

	Project Cost	Simple Payback
QRIP	\$5,000-\$100,000	≤ 2 yrs.
OSD PIF	> \$100,000	≤ 4 yrs.
PECIP	> \$100,000	≤ 4 yrs.
ECIP	> \$200,000	≤ 10 yrs., SIR > 1.0
MCA	> \$200,000	≤ 25 yrs., ≥ 8 yrs.

DA Form 1391 is required only for those ECIP and MCA projects costing greater than \$200,000. Otherwise, DA Form 5108-R from AR 5-4 is used.

Table 5-1 contains the results of the analysis with the project funding category listed in the far right column and is summarized in Table 5-2. Table 5-3 lists the ECOs by project funding category.

Three projects, ECO 13, Reduce Air Flow; ECO 16, Return Air System; and ECO 19, Occupancy Sensor have paybacks less than four years, but do not meet the project cost minimum. Projects 8C, 8D and 8H are being funded in favor of 8A, 8B, 8E, 8F and 8G. ECO 2, Natural Gas Switch, qualifies for ECIP funds, but is likely to be funded by Niagara-Mohawk Power Company. Cogeneration, ECO 3, qualifies for ECIP funding, but requires further study due to the large cost, \$1.3 million. It also requires the natural gas line to be completed to the main boiler plant (ECO 2). Project 15, EMCS, does not meet ECIP requirements, but could be funded under MCA.

5.2 Energy and Cost Savings

Energy and cost savings for the recommended project funding are listed in Table 5-4. Project capital costs are escalated at 4 percent per year according to the project implementation schedule as discussed below. Energy costs are in constant dollars using FY 92 prices. The implementation of all projects yield a total annual energy savings of 45,900 MBtu and annual cost

Table 5-1. ECO Evaluations - Project Funding - Prioritized by Simple Payback

No.	ECO #	Project Name	Construction Cost Plus SIOH	Savings (Increase), MBtu/Year Elec	Dist	Resid	N Gas	Net Annual Cost Savings	SIR	Simple Payback (yrs)	Project Funding
1	5	Elec. Demand Peak Reduction	$0	0	0	0	0	$151,000	∞	0	
2	6	Condensate Return	$16,712	0	0	2,255	3,205	$23,300	24.1	0.8	QRIP
3	12	Natural Gas Boilers	$47,268	2,497	0	0	(3,122)	$37,800	10.7	1.3	QRIP
4	13	Air Flow Reduction	$969	31	0	25	0	$740	11.4	1.4	NF
5	4	Dip Tank Covers & VSDs	$202,576	2,707	0	21,650	0	$141,900	11.6	1.5	OSD PIF
6	8A	34 W FL-Prod	$2,065	51	0	0	0	$970	6.8	2.2	NF
7	19	Occupancy Sensors	$11,976	211	0	0	0	$4,600	5.5	2.8	NF
8	10	High-Efficiency Motors	$111,227	1,602	0	0	0	$32,600	4.2	3.6	OSD PIF
9	16	Return Air System	$66,495	0	0	3,985	0	$17,500	4.6	4.0	NF
10	8H	60W FL-Prod	$367,198	4,478	0	0	0	$91,200	3.6	4.3	ECIP (2)
11	8C	T8 FL&EB-Prod	$10,490	117	0	0	0	$2,400	3.3	4.7	ECIP (2)
12	1	Power Factor Improvement	$138,786	0	0	0	0	$31,000	3.1	4.7	NF
13	8D	34W FL-NonProd	$52,591	589	0	0	0	$11,300	3.1	4.9	ECIP (2)
14	8G	60W FL-Prod	$64,691	768	0	0	0	$13,200	3.0	5.2	NF
15	2	Natural Gas Fuel Switch	$364,051	0	0	278,000	(278,000)	$66,700	4.4	5.8	NF
16	8B	34 W FL&EB-Prod	$12,299	102	0	0	0	$2,000	2.6	6.1	NF
17	8J	60W FL&EB-NonProd	$60,651	339	0	0	0	$7,100	1.7	9.0	NF
18	3	Cogeneration	$1,303,232	0	0	28,400	(77,700)	$140,500	1.0	9.8	NF
19	18	Storm Windows (1)	$107	0.02	0	2.55	0	$11	1.8	10.5	NF
20	8I	60W FL-NonProd	$108,685	58	0	0	0	$15,500	1.4	11.2	NF
21	15	EMCS	$522,900	0	0	9,851	0	$49,600	1.1	11.2	MCA
22	8F	T8 FL&EB-NonProd	$361,167	1,399	0	0	0	$30,600	1.3	12.5	NF
23	8E	34W FL&EB-NonProd	$316,753	1,104	0	0	0	$24,900	1.3	13.4	NF
24	14	High-Efficiency Chiller	$141,184	363	0	0	0	$7,400	0.8	20.2	NR
25	17	Double-Pane Wind. (1)	$495	0.02	0	2.55	0	$12	0.5	45.9	NR
26	9	Not Used	--	--	0	0	0	--	--	--	--
27	11	Boiler O2 Trim Controls	--	--	--	--	--	--	--	--	--
28	7	Condenser Fan VSDs	--	--	--	--	--	--	--	--	--

Note : VSD = Variable speed drive
FL = Fluorescents
EB = Electronic ballasts
Prod = Production areas
NonProd = Non-production areas
NF = Does not meet funding requirements

NR = Not recommended
T8 = T8 fluorescent
(1) Per unit basis
(2) Combined into a single ECIP

Table 5-2. ECO Evaluations - Project Funding Summary - Grouped by Funding Category

No.	ECO #	Title: ECO Names	Construction Cost Plus SIOH	SIR	Simple Payback (yrs)	Project Funding
1	5	Elec. Demand Peak Reduction	$0	∞	0	--
2	6	Condensate Return	$16,712	24.1	0.8	QRIP
3	12	Natural Gas Boilers	$47,268	10.7	1.3	QRIP
4	4	Dip Tank Covers & VSDs	$202,576	11.6	1.5	OSD PIF
5	10	High-Efficiency Motors	$111,227	4.2	3.6	OSD PIF
6	8C	T8 FL&EB-Prod	$10,490	3.3	4.7	ECIP (1)
7	8D	34W FL-NonProd	$52,591	3.1	4.9	ECIP (1)
8	8H	60W FL-Prod	$367,198	3.6	4.3	ECIP (1)
9	15	EMCS	$522,900	1.1	11.2	MCA
10	1	Power Factor Improvement	$138,786	3.1	4.7	NF
11	2	Natural Gas Fuel Switch	$364,051	4.4	5.8	NF
12	3	Cogeneration	$1,303,232	1.0	9.8	NF
13	8A	34 W FL-Prod	$2,065	6.8	2.2	NF
14	8B	34 W FL&EB-Prod	$12,299	2.6	6.1	NF
15	8E	34W FL&EB-NonProd	$316,753	1.3	13.4	NF
16	8F	T8 FL&EB-NonProd	$361,167	1.3	12.5	NF
17	8G	60W FL-Prod	$64,691	3.0	5.2	NF
18	8I	60W FL-NonProd	$108,685	1.4	11.2	NF
19	8J	60W FL&EB-NonProd	$60,651	1.7	9.0	NF
20	13	Air Flow Reduction	$969	11.4	1.4	NF
21	16	Return Air System	$66,495	4.6	4.0	NF
22	19	Occupancy Sensors	$11,976	5.5	2.8	NF
23	18	Storm Windows (2)	$107	1.8	10.5	NF

Note :
VSD = Variable speed drive
FL = Fluorescents
EB = Electronic ballasts
Prod = Production areas
NonProd = Non-production areas
NF = Does not meet funding requirements
NR = Not recommended

T8 = T8 fluorescents
(1) Combined into a single ECIP
(2) Per unit basis

Table 5-3. Project Funding List

Funds	ECO #	Project Description
QRIP	6	Condensate Return
	12	Natural Gas Boilers
OSD PIF	4	Dip Tank Covers and Variable-Speed Drive
	10	High-Efficiency Motors
ECIP	8	High-Efficiency Lighting
MCA	15	EMCS

Table 5-4. Energy and Cost Savings for Recommended Projects

#	Project Names	Construction Cost Plus SIOH (1)	Annual Energy Savings (MBtu/Yr)	Annual Energy Savings $(2)	Project Type	Year
5	Peak Demand Reduction	$0	0	$151,000	--	FY92
6	Condensate Return	$16,700	5,460	$23,300	QRIP	FY93
12	Natural Gas Boilers	$47,300	(625) (3)	$37,800	QRIP	FY93
4	Dip Tank Covers and VSDs	$202,600	24,357	$141,900	OSD PIF	FY93
10	High-Efficiency Motors	$111,200	1,602	$32,600	OSD PIF	FY93
8C, D, H	High-Efficiency Lighting	$430,300	5,184	$104,900	ECIP	FY96
15	EMCS	$522,900	9,851	$49,600	MCA	FY96
2	Natural Gas Fuel Switch	$364,100	0	$66,700	(4)	FY93
	TOTALS	$1,695,100	45,829	$607,800		

(1) Escalated to year of implementation.
(2) Energy costs are in constant FY92 dollars.
(3) Cost savings come from fuel switch from electricity to natural gas.
(4) Proposed to be funded by Niagara-Mohawk Power Corporation.

savings equal to $607,800, which represents a reduction of eight percent and ten percent, respectively in energy use and cost when compared to FY 91 values. Figures 5-1 through 5-4 show energy use and cost at WVA before and after implementation of these projects. Note that about $700,000 of the utility cost decrease is due to the large drop in the price of No. 6 fuel oil between FY 91 and FY 92.

5.3 Project Schedule

Project implementation dates are estimated as follows:

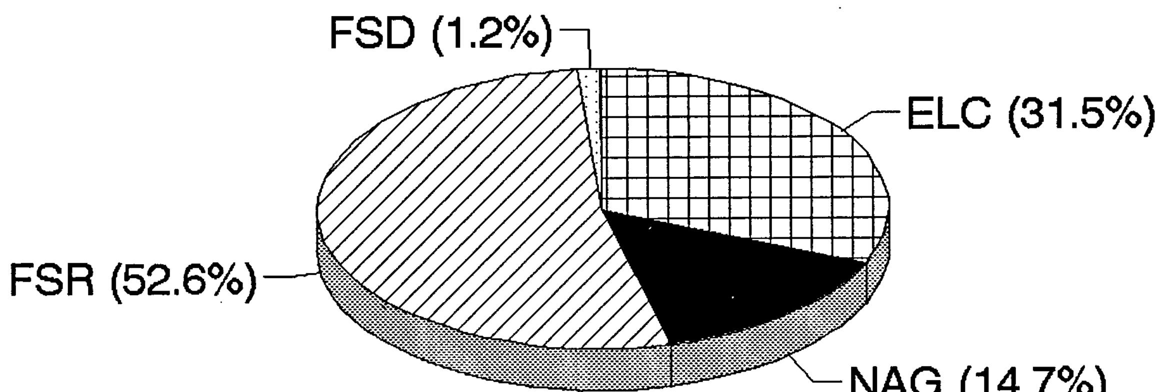
QRIP, OSD PIF	FY 93
ECIP, MCA	FY 96

Following this schedule, Figures 5-5 and 5-6 show how implementation of the recommended projects reduce energy use and cost, respectively, at WVA.

5.4 Environmental Impact

Another benefit of reducing energy use is the accompanying reduction in emissions from heating plants and electric utilities. Table 5-5 contains the results of an analysis performed using emission data collected from engineering periodicals and Niagara-Mohawk Power Corporation. When all projects are implemented, the reduction of emissions in the atmosphere are over 10,000 tons each year.

Watervliet Arsenal
FY91 Facility Energy Use

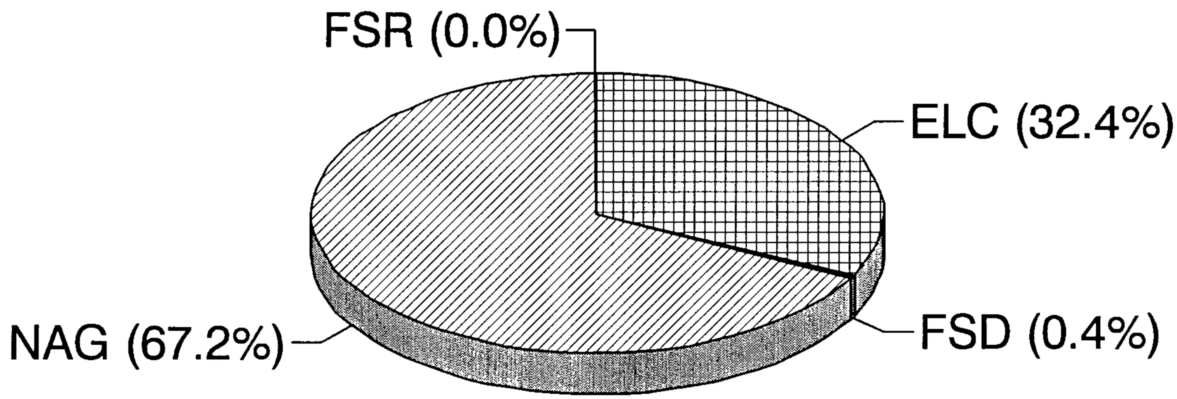


Total Use = 571,000 MBtu

Figure 5-1

Watervliet Arsenal

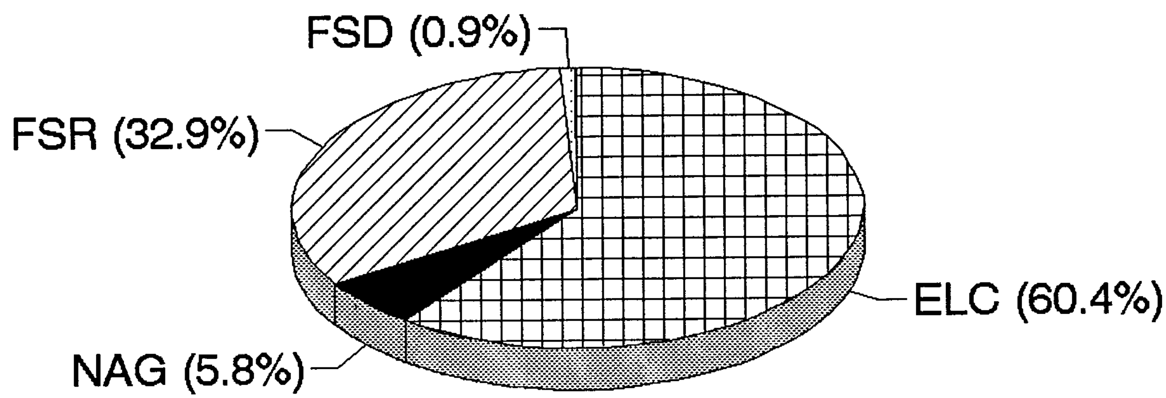
Energy Use After Project Implementation



Total Use = 525,000 MBtu

Figure 5-2

Watervliet Arsenal
FY91 Facility Energy Cost

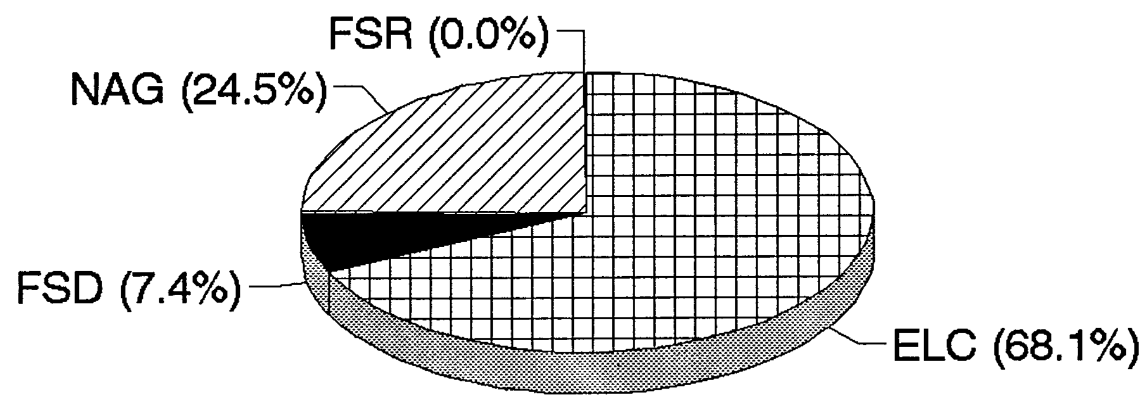


Total Cost = $ 6,024,000

Figure 5-3

Watervliet Arsenal

Energy Cost Aft. Project Implementation



Total Use = $ 4,700,000

Figure 5-4

Watervliet Arsenal

Effects of Energy Projects

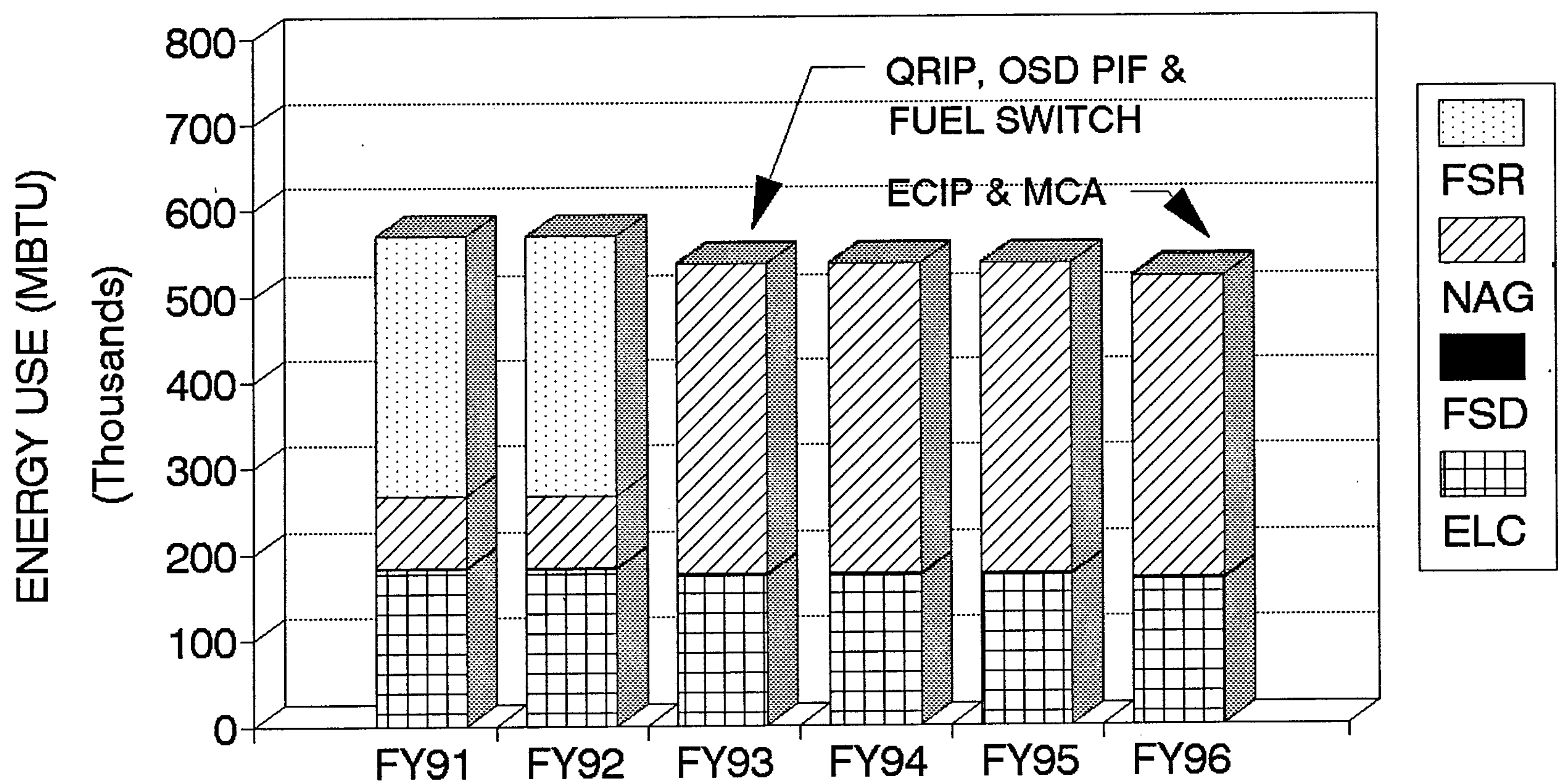


Figure 5-5

Watervliet Arsenal
Effects of Energy Projects

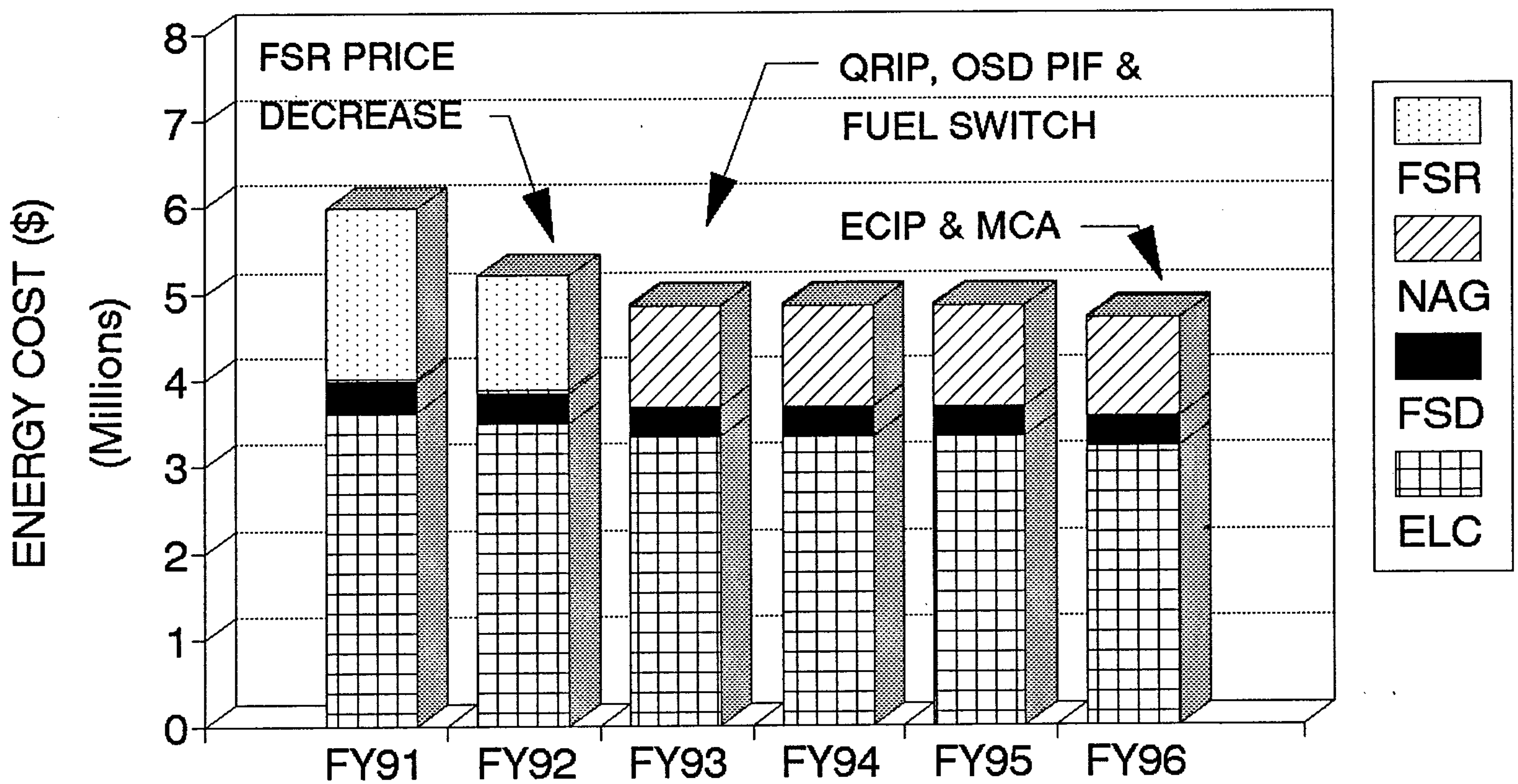


Figure 5-6

Table 5-5 Emission Reductions Due to Energy Saving Projects

ECO #	Project Name	Emissions (lbs/yr) SO2	NOx	Part.	CO2
6	Condensate Return	2,400	1,500	200	733,600
12	Natural Gas Boilers	8,800	700	700	871,100
4	Dip Tank Covers & VSDs	32,900	7,900	2,700	4,975,500
10	High Efficiency Motors	5,600	900	500	779,200
8C,D,H	High Efficiency Lighting	18,200	3,000	1,500	2,521,400
15	EMCS	10,600	2,900	900	1,664,800
5	Peak Demand Reduction	0	0	0	0
2	Natural Gas Fuel Switch	300,200	11,100	25,000	16,402,000
	TOTALS (lbs/yr)	378,700	28,000	31,500	27,947,600
	TOTALS (tons/yr)	200	14	16	14,000

SO2 - Sulfur Dioxide
NOx - Nitrogen Oxides
Part. - Particulates
CO2 - Carbon Dioxide